Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

NOVEMBER, 1948 TECHNOLOGY DEPARTMENT

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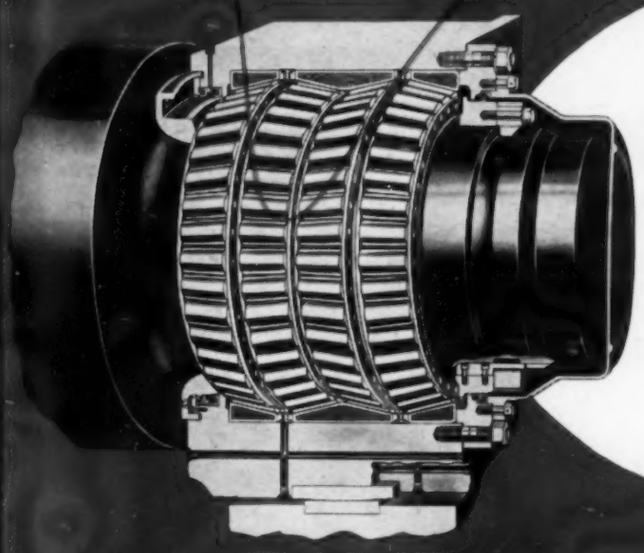
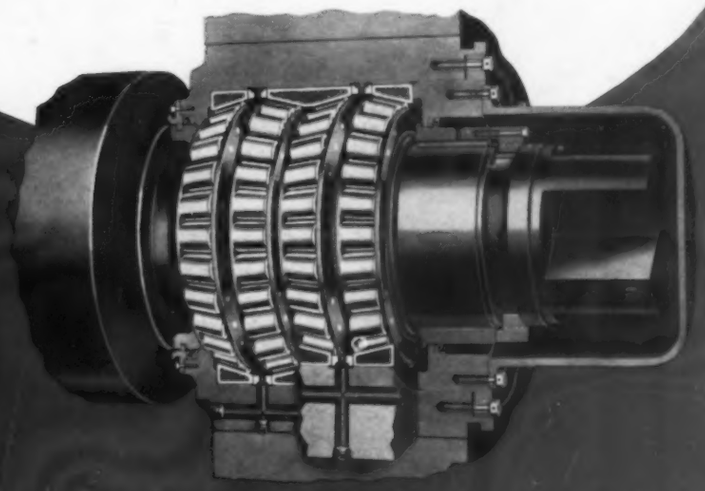
NOV 2
DETROIT

HIGHER ROLLING MILL SPEEDS WITH GREATER MILL RIGIDITY



Today



Yesterday

As rolling speeds and loads go higher and higher, the necessity for increased mill rigidity becomes greater and greater.

Timken Balanced Proportion rolling mill bearings are definite factors of high speed mill operation because they eliminate roll neck friction. They make possible more rigid mills because balanced proportion design permits larger diameter roll necks than were possible with previous designs of tapered roller mill bearings.

No separate thrust members are required with Timken roll neck bearings. All loads — radial, thrust and both combined — are efficiently handled within the geometry of the bearing.

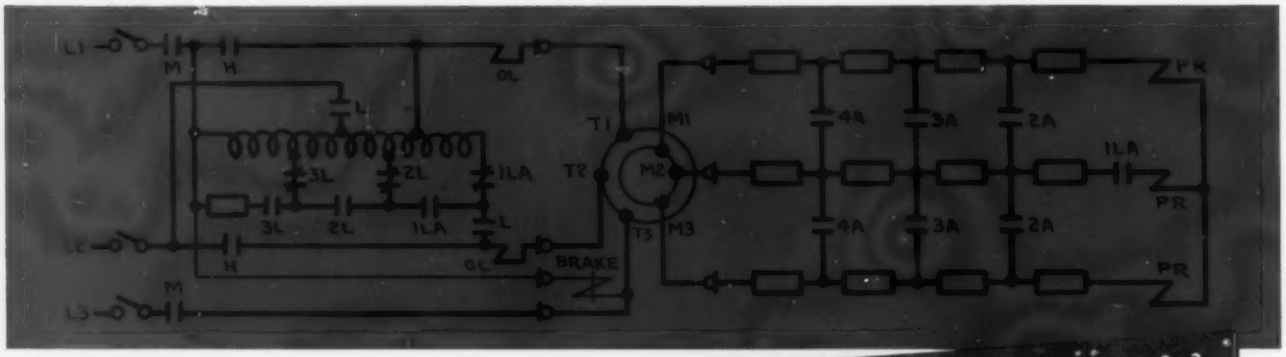
No complicated lubricating systems are needed with Timken roll neck bearings. Roll changing is simplified. Maintenance is reduced.

TIMKEN
TRADE-MARKS REG. U. S. PAT. OFF.
ROLL NECK BEARINGS

Past performance proves that the tonnage life expectancy of Timken roll neck bearings is greater than that of any other bearings used on mill roll necks. The Timken Roller Bearing Company, Canton 6, Ohio. Cable address "TIMROSCO".

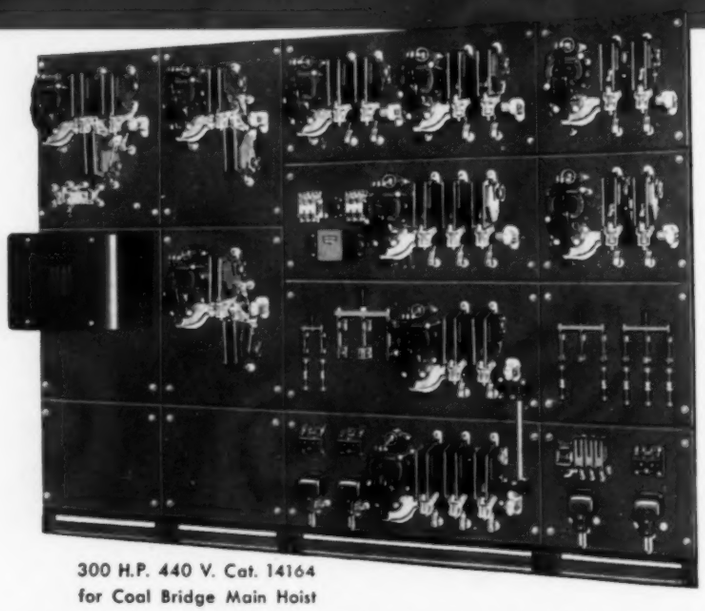
NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ↓ AND THRUST →○← LOADS OR ANY COMBINATION →↓←

What control for what mill equipment? One of a SERIES of advertisements featuring basic heavy duty power circuits . . . and showing Cutler-Hammer's broad design and application experience which has made it the preferred control for the steel industry.



When you want positively controlled dynamic braking on an A-c crane hoist

Then call for . . . . . CUTLER-HAMMER 14164 A-c Dynamic Lowering Control



300 H.P. 440 V. Cat. 14164 for Coal Bridge Main Hoist

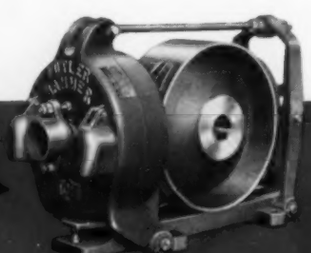
It is no longer necessary to select direct current crane motors when you want maximum crane hoist performance. Nor is it necessary to put up with costly and troublesome load lowering brakes on alternating current crane hoists.

Cutler-Hammer Bulletin 14164 A-c Dynamic Lowering Control provides, not only completely satisfactory performance in hoisting, but five stable and selective speeds in the lowering direction, accurate inching, dynamic braking, timed acceleration in both directions and timed deceleration for spotting a load.

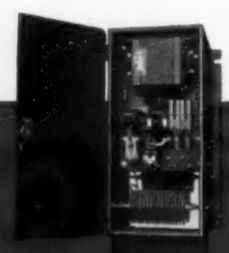
Cutler-Hammer A-c Dynamic Lowering Control can be used with any crane type slip ring motor and is available in manual and magnetic types. Specify this outstanding A-c crane control engineering development on your next crane... CUTLER-HAMMER, Inc., 1269 St. Paul Ave., Milwaukee 1, Wis. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ont.

CUTLER-HAMMER
MOTOR CONTROL
C-H

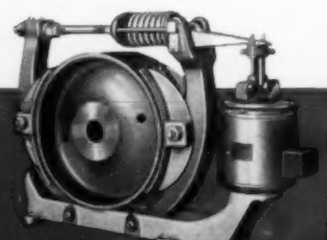
Typical Components ...of... CUTLER-HAMMER Mill Control



Famous C-H Type M D-c brake...standard for the steel industry.



Control panel with rectifier for using D-c brake with A-c crane control.



Type TM Brake (Torque Motor Operated) for A-c cranes.

IRON AND STEEL ENGINEER, published monthly by Association of Iron and Steel Engineers, 1010 Empire Bldg., entered as second class matter January 25, 1924 at Pittsburgh, Pennsylvania, under Act of Congress March 3, 1879. $7.50 per year in United States, $8.25 Canada, $10.00 foreign countries. Volume 25, No. 11.

Have you checked on your speeds lately?

Continuous butt weld pipe zooms out of Aetna-built mills today as fast as 500′ per minute. New mills under construction will produce pipe as fast as 1000′ per minute. Rate in near future for seamless tube production will be far in excess of present speeds.

Engineers at Aetna-Standard and industry specialists combine talents for improving cold drawing production. Speeds have moved forward. Now, three non-ferrous tubes can be drawn simultaneously as fast as 300′ per minute.

The versatile Aetna wire drawing machine makes possible drawing speeds ranging up to 3000′ per minute for medium ga. steel wire (.020″ dia.). Higher speeds are of course possible with non-ferrous material.

Continuous strip galvanizing has become a reality . . . production up to 300 feet per minute. Speeds on hot dip galvanizing of sheets have been increased from 30 feet to 50 feet per minute.

Continuous terne plate production has increased from 60 feet to 120 feet per minute and speeds on other strip products have been greatly improved.

Aetna-Standard, an engineering company, designs, builds and installs mill equipment for production or processing of steel, brass, copper and aluminum.

THE AETNA-STANDARD ENGINEERING COMPANY

YOUNGSTOWN, OHIO

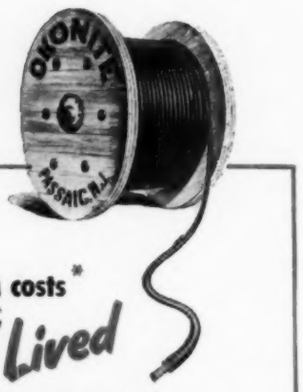
ASSOCIATED COMPANIES:

HEAD, WRIGHTSON & COMPANY, LTD., THORNABY-ON-TEES, ENGLAND

AETNA-STANDARD ENGINEERING COMPANY, LTD., TORONTO, ONTARIO, CANADA

ONLY COMPLETELY-PROTECTED CONDUCTORS ASSURE *Longest-Lived* WIRES AND CABLES

. . . and only Okolite-Okoprene cables possess these 9 "factors of protection"



With today's installation costs* only the *Longest-Lived* will be economical

*The lifetime cost of a cable rather than its first cost is the only true measure. Okonite wires and cables, built to stand up better and longer, can offset high installation costs.

❶ Conductors are coated with corrosion-resistant Okoloy, a lead alloy that outlasts tinning 2 to 1.

❷ Internal corona cutting is eliminated and dielectric strength increased by Semicon Tape applied over the conductor on all Okolite-Okoprene cables operating at over 2000 volts.

❸ Moisture-resisting, high-voltage Okolite, an oil-base insulation proved in over 20 years of service, is made with Up-River Fine Para, the best grade of natural rubber. Approved as Type RWSN by Underwriters' Laboratories.

❹ The Okoprene covering, a pioneering development of the Okonite laboratories, has established its stability and permanence on millions of feet of cable installed since 1935 under the most severe conditions.

❺ Both insulation and jacket are applied together in a single operation by the strip-process and uniformly vulcanized in a continuous metal mold to give the best and most dependable bond.

❻ Insulation and covering receive but a single vulcanizing "cure" thus eliminating the life-shortening effects of double vulcanization.

❼ Thickness of both insulation and jacket are accurately controlled by the Okonite strip-insulating process.

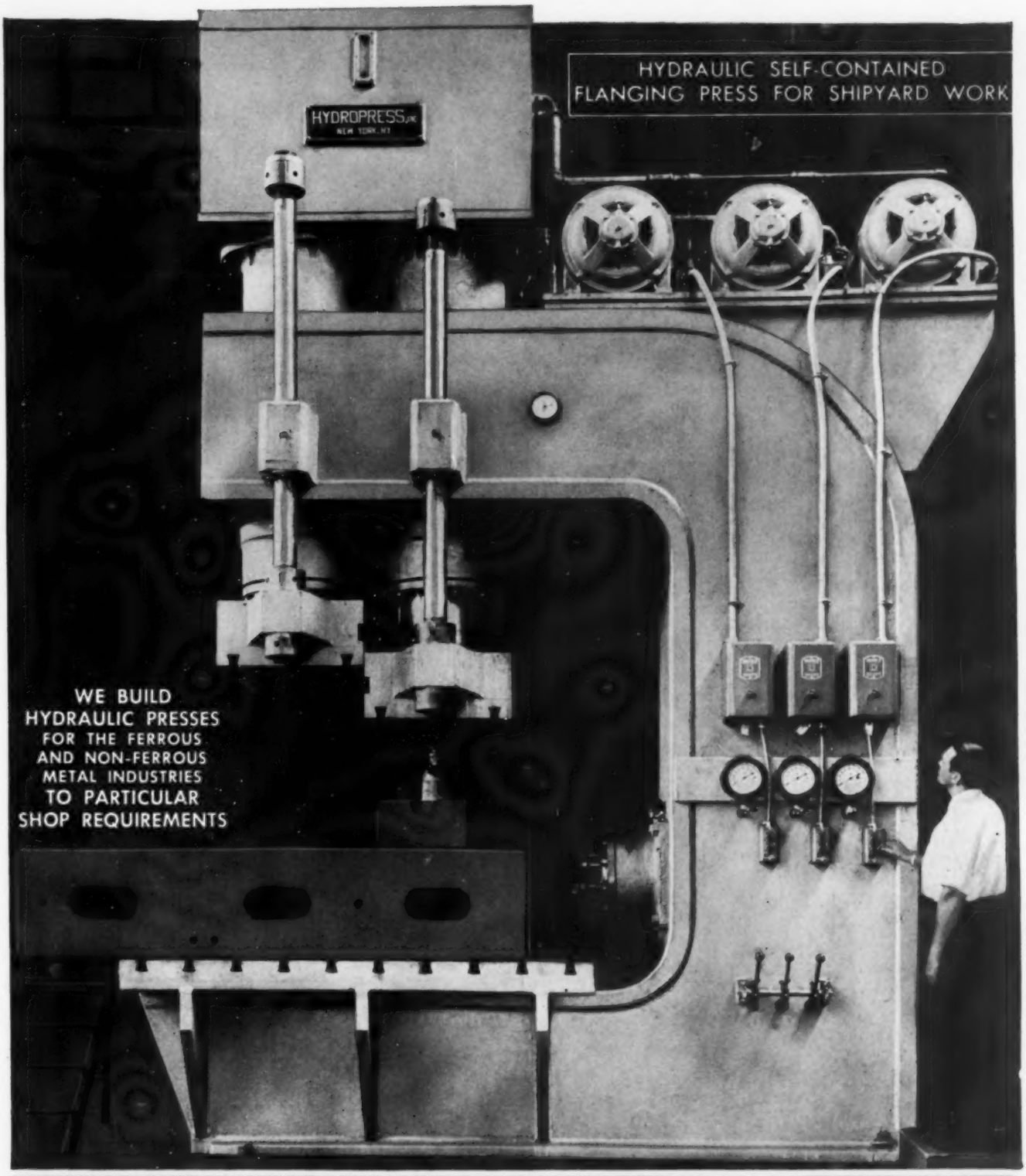
❽ In addition to a. c. tests, every Okolite-Okoprene cable is subjected to high-voltage d. c. tests more severe than used by any other cable manufacturer.

❾ Okolite-Okoprene cables have the longest and most extensive service record.

Okolite-Okoprene's electrical operating advantages, installation advantages and design advantages are given along with dimensional data in illustrated, information-crammed Bulletin IS-1037. For a copy, please address The Okonite Company, Passaic, New Jersey.

OKONITE OKONITE SINCE 1878 **insulated wires and cables**

THE BEST CABLE IS YOUR BEST POLICY



HYDROPRESS · INC.

ENGINEERS *CONTRACTORS*

HYDRAULIC PRESSES · ROLLING MILLS · PUMPS
ACCUMULATORS · DIE CASTING MACHINES

566-568 LEXINGTON AVENUE · NEW YORK 22 · N. Y.

CHICAGO DETROIT SAN FRANCISCO SEATTLE WASHINGTON, D. C.

Protect your Profit Margin

WITH

MORGAN WORCESTER

ROLLING MILL EQUIPMENT

While demand continues high for all types of rolling mill products some mills find it harder and harder to break even . . . literally starving in the midst of plenty.

If you are surprised at your high break-even point, why not have a Morgan engineer examine your methods and recommend steps to bring your costs in line?

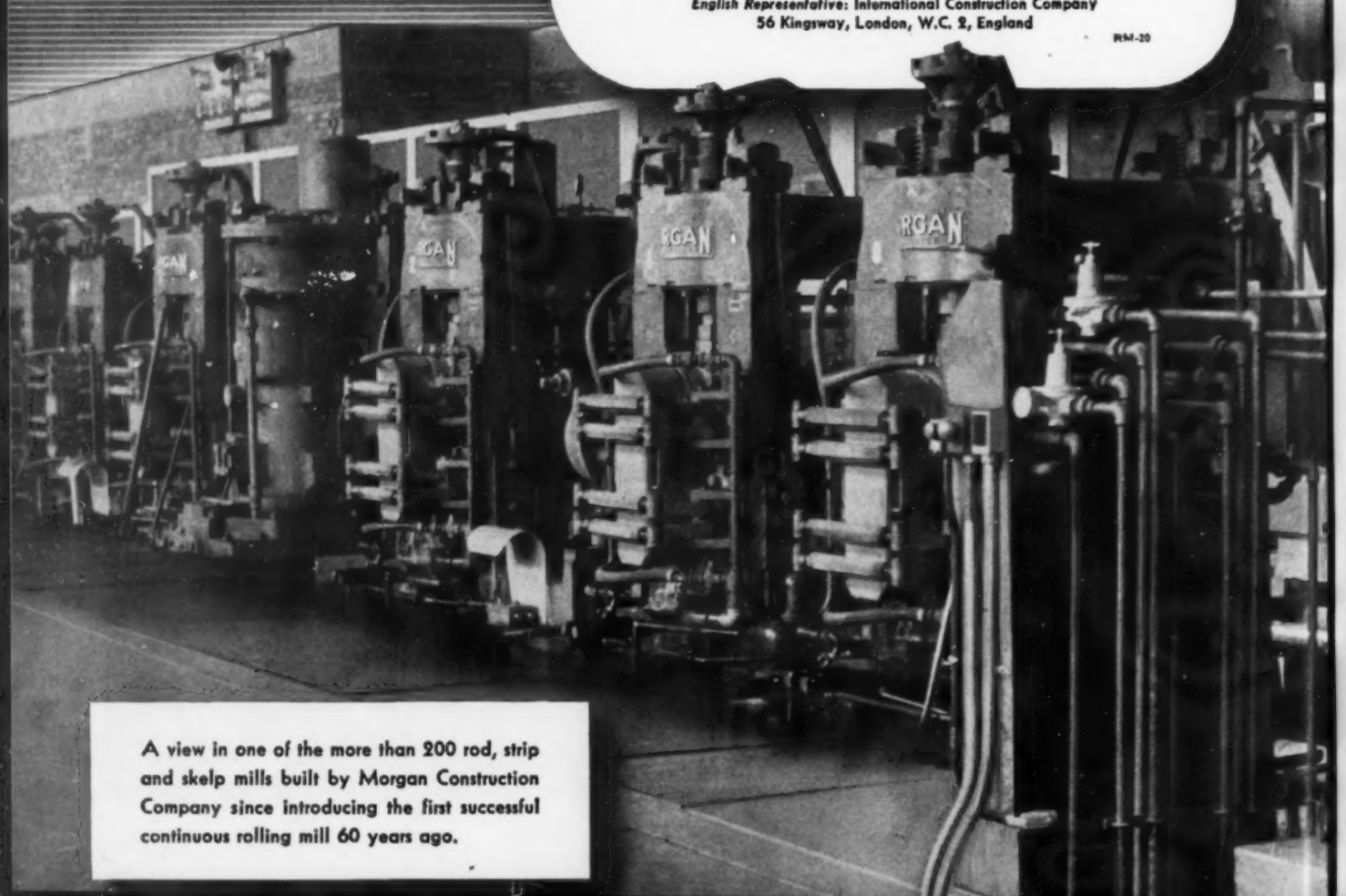
MORGAN CONSTRUCTION CO.

WORCESTER, MASSACHUSETTS

Rolling Mills - Morgoil Bearings - Wire Mills
Regenerative Furnace Control - Air Ejectors

English Representative: International Construction Company
56 Kingsway, London, W.C. 2, England

RM-20



A view in one of the more than 200 rod, strip and skelp mills built by Morgan Construction Company since introducing the first successful continuous rolling mill 60 years ago.

Hold Steel Quality...

Speed Up Steelmaking with Regulex Mill Control!

CONTROL BOARD used with *Regulex* exciters above. Allis-Chalmers builds a complete line of control for: Reversing Blooming Mills; Structural Mills; Hot Strip Mills; Cold Reduction Mills; Temper Mills; Arc Furnaces; etc.

MAINTAIN AUTOMATIC, accurate control of tension, speed, acceleration, deceleration, or other drive-motor function with Allis-Chalmers control using *Regulex* exciters. Production can be speeded without loss of quality because the *Regulex* exciter has high-speed response and extreme sensitivity . . . providing d-c variable voltage control that permits rapid speed changes and regulates to close limits. The control offers wide flexibility in application.

For information on the complete line of Allis-Chalmers control, contact your nearby A-C office. Or write ALLIS-CHALMERS, MILWAUKEE 1, WISCONSIN.

A 2523

Reptair and *Regulex* are Allis-Chalmers trademarks

ALLIS-CHALMERS

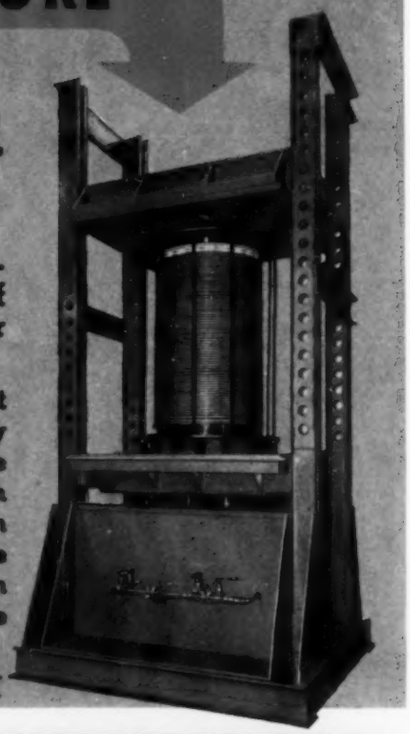
Power, Electrical, Processing Equipment for Iron and Steel

PUTTING ON THE PRESSURE

GIVES POSITIVE PROOF THAT YOUR TRANSFORMER WILL WITHSTAND SHORT CIRCUITS

It's sure. It's positive. No guess work. No wishful thinking. Putting on the pressure is an added measure of safety engineered into every Pennsylvania Transformer with helical or pancake coils.

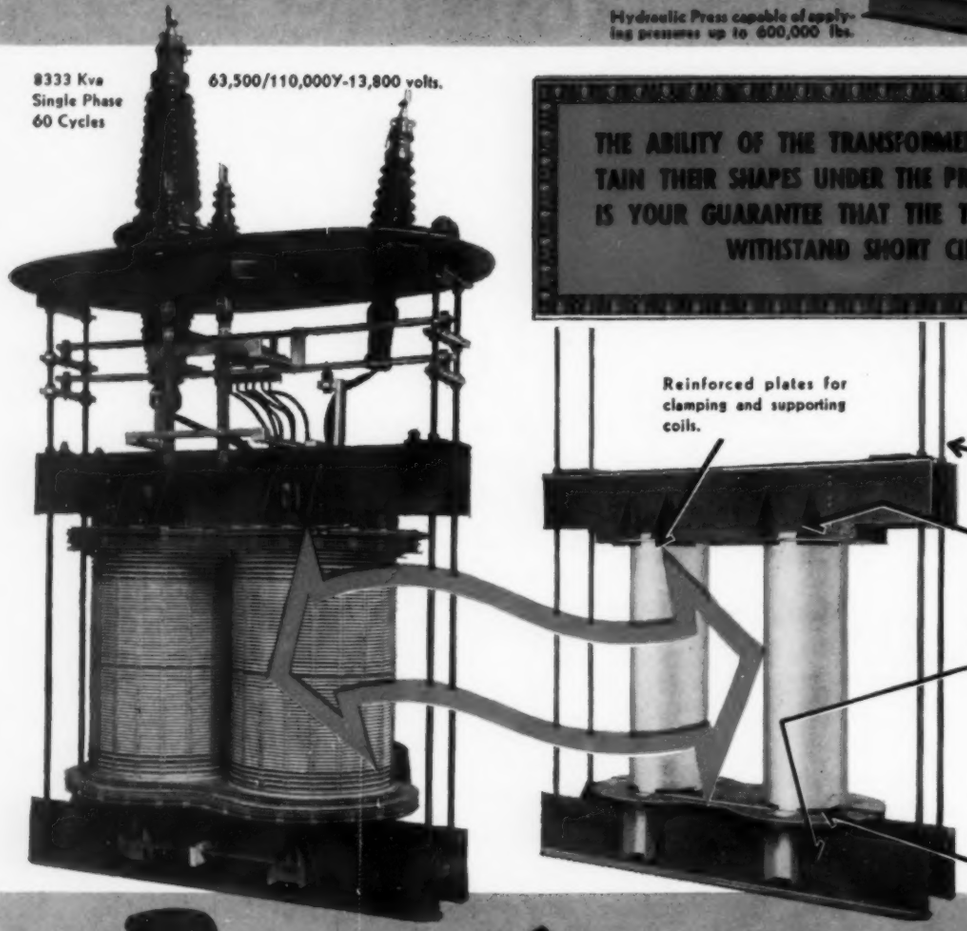
THIS IS WHAT WE DO — We calculate the total short circuit force that would be produced by a short circuit at the secondary terminals with the rated voltage maintained on the primary. We compress the coils with this pre-determined force and treat them in such a manner that they are self-supporting, and will maintain their shapes when mounted on the core. Strong supports are provided at the top and bottom of the coils to keep the coils in their precompressed shapes. No movement can take place in the transformer coils, even under the most severe short circuit.



Hydraulic Press capable of applying pressures up to 600,000 lbs.

8333 Kva
Single Phase
60 Cycles

63,500/110,000Y-13,800 volts.



THE ABILITY OF THE TRANSFORMER COILS TO MAINTAIN THEIR SHAPES UNDER THE PRESCRIBED PRESSURE IS YOUR GUARANTEE THAT THE TRANSFORMER WILL WITHSTAND SHORT CIRCUITS.

Reinforced plates for clamping and supporting coils.

Tie rods for connecting top and bottom core frames and for clamping coils.

Clamping plates hold coils to their precompressed size. Note the ruggedly constructed side-frames, the extra strong bolts, nuts and rods.

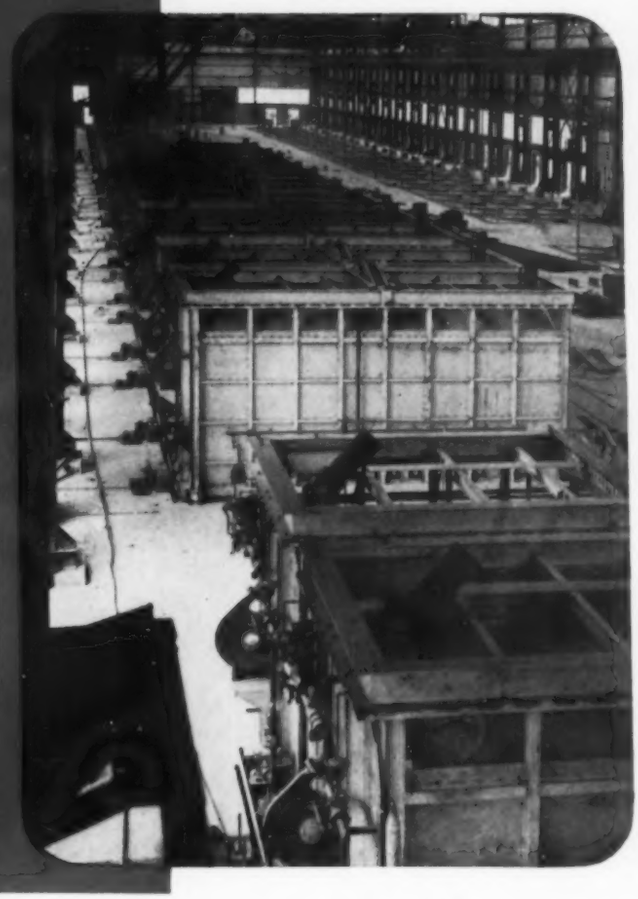
Drum cut away to permit cooling oil to flow past core steel.

Pennsylvania
TRANSFORMER CO., PITTSBURGH, PA.

Pennsylvania TRANSFORMERS

F.E.I.

PATENTED COMBUSTION SYSTEM



F.E.I. *builds:*

For Blooming, Plate & Rolling Mills

Soaking Pits for all fuels.
Continuous Bloom, Billet and Slab Heating Furnaces.

Furnaces Equipped with F. E. I. Patented Combustion System

For Wire, Bar or Tube Mills

Galvanizing, Patenting or normalizing Furnaces.
Cover Furnaces for bright annealing, heat treating, normalizing and spheroidizing of wire and rod products.

For Pipe, Sheet or Jobbing Plants

Hot Dip Galvanizing Furnaces.
Salt Bath descaling furnaces for stainless steel sheet, bar and other products.

Strip Mills

Direct fired Cover Furnace for flat sheet and coil annealing, utilizing a patented base assembly.

CONSULT WITH US ON YOUR SPECIAL HEATING PROBLEMS

increases production reduces fuel costs

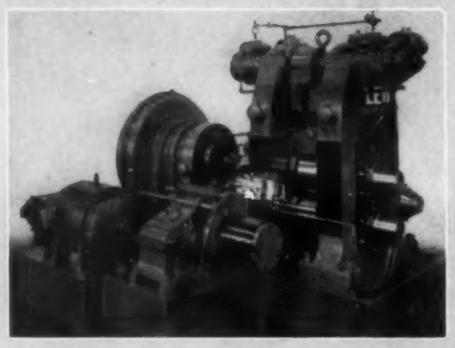
The F.E.I. combustion system provides uniform top and bottom temperatures because of a double pass of the products of combustion around the mixer covers before leaving the furnace, thus eliminating the possibility of localized overheating. The F.E.I. combustion system is completely automatic, providing maximum fuel burning capacity for high production demands but at the same time permitting high turn down ratios for extended soaking periods.

FURNACE ENGINEERS, *Inc.*

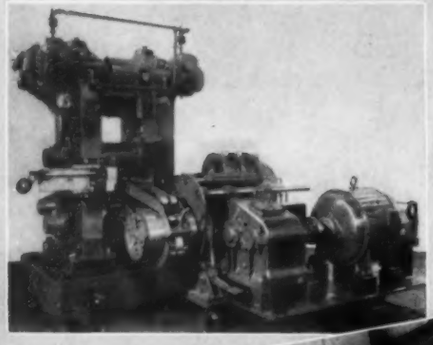
Representation in all Foreign Countries.

1551 WEST LIBERTY AVENUE ★ PITTSBURGH, PA.

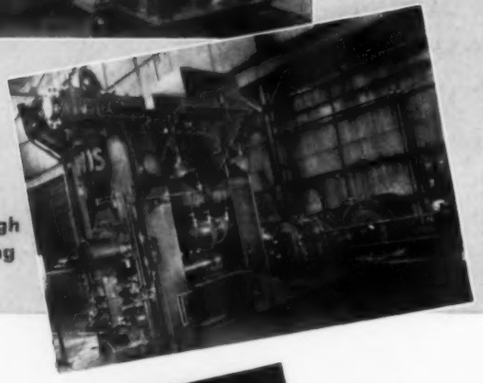
Lewis 500-Ton Gag Press



Lewis Two-High Skin Pass Mill



Lewis Four-High Small Strip Mill



Lewis Four-High Finishing Mill

Experience PROVIDES THE ANSWERS

Lewis engineers draw on a background of experience gained from long familiarity with the intimate details and problems of rolling mill operation.

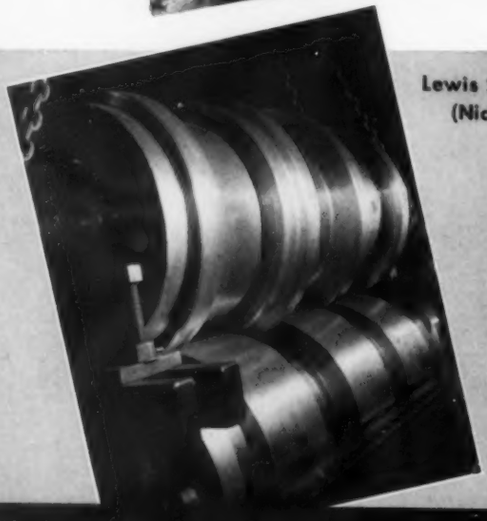
This results in machines that "do it better for less"—machines that are ahead of their time today, but become "standard" tomorrow. Perhaps such a mill-minded approach can be applied to your operation now with gratifying results.

LEWIS MAKES

Beds—Cooling
Blanks—Gear • Pinion
Boxes—Coupling
Castings—Rolling Mill Furnace
Coilers—Ferrous and Non-ferrous Strip
Gear Drives
Gears and Pinions—Bevel • Double Helical • Single Helical • Speed Reduction • Spur
Housing Pinion—Rolling Mill
Lathes—Roll Turning
Levelers—Roller for Plate and Sheet
Machinery—Special • Flaking Mill • Rolling Mill
Machines—Pickling
Manipulators—Rolling Mill
Mills—Aluminum Foil • Bar • Billet and Blooming • Brass and Copper • Cold Rolling • Continuous • Edging • Four-High • Single Stand • Reversing and Tandem • Merchant • Plate Rolling • Precision • Sheet and Strip • Slabbing • Three-High • Tin Plate • Universal • Wire • Zinc Strip • Roughing and Finishing
Reels—Tension
Roll Ragging Attachments
Roll Polishers
Rolls—Alloy Iron • Chilled Iron • Sand and Chilled Iron • Steel
Saws—Hot and Cold
Screwdowns—Motor Operated • Hand Operated
Shears—Alligator • Bar • Billet • Bloom • Continuous Automatic • Sheet Mill • Gate or Guillotine • Lever • Plate • Power Driven • Scrap • Vertical
Straighteners—Angle • Bar • Rails and Shapes
Tables—Blooming Mill • Rolling Mill Feed • Transfer for Mills

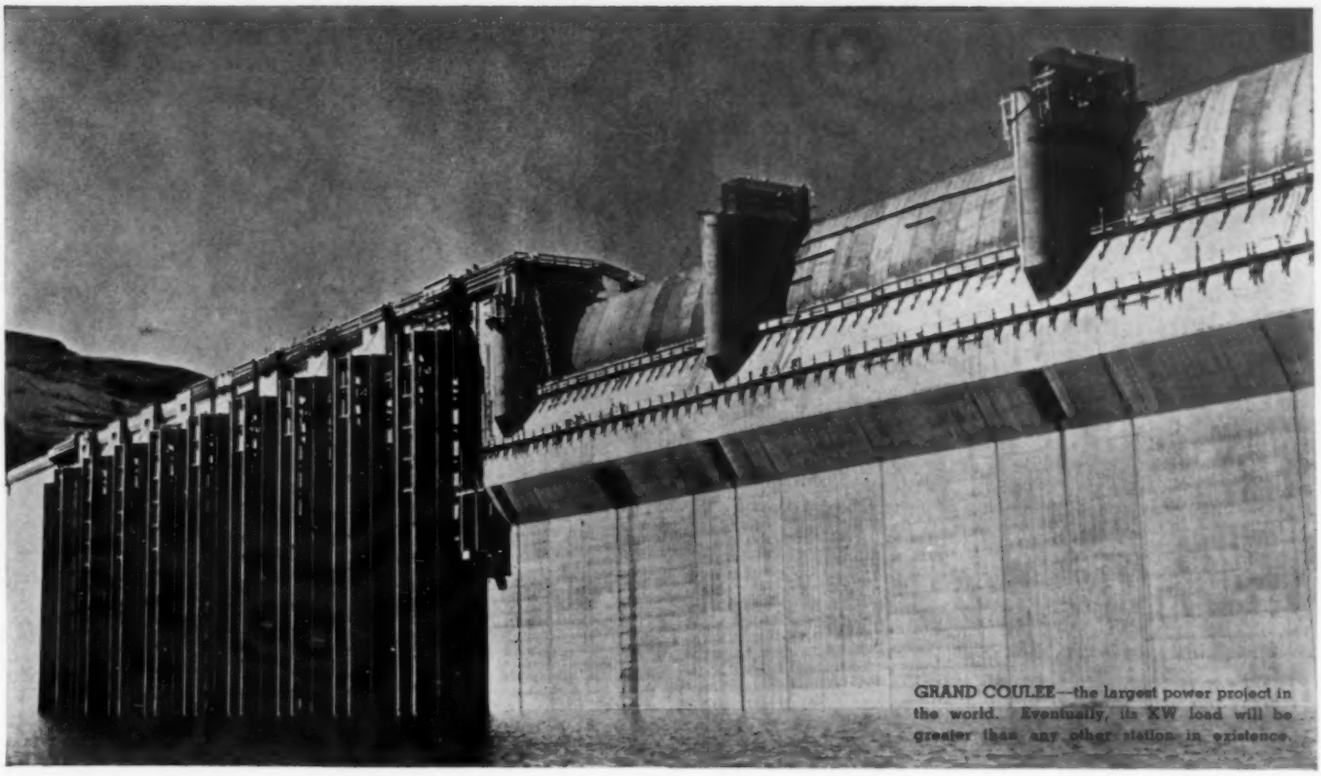
LEWIS FOUNDRY & MACHINE
Division of Blaw-Knox Co.
Pittsburgh, Pa.

Designers and Builders of Rolls and Rolling Mill Equipment



Lewis Superior "X" Rolls (Nickel Grain Type)

LEWIS ROLLING MILL EQUIPMENT



GRAND COULEE—the largest power project in the world. Eventually, its KW load will be greater than any other station in existence.

When Bigger Stations than GRAND COULEE are built EC&M VALIMITOR Starters will give protection without change

The problem of selecting 2300-4600 volt motor starting equipment with adequate short circuit protection is now greatly simplified. No further need for fault analyses of systems . . . no need to worry about original calculations being upset by a future increase in capacity causing costly equipment changes. EC&M VALIMITOR (volt-ampere-limitor) Starters give *permanent* protection.

These starters are equipped with air-core reactors designed to limit fault currents to a maximum of 25,000 KVA (steady state) even if the system had infinite KVA capacity available. Connected to a bus of normal capacity, EC&M VALIMITOR Starters are more than adequate to interrupt the fault on *any* motor circuit they protect. They also limit the electromagnetic forces and thermal effects to safe values. No replacements needed to re-start, after a fault.

Don't risk the chance that analysis may be outmoded by changes made one year from now—in two years or longer. For the complete solution, simply tell us the HP, voltage, phase and frequency of the motors, and whether squirrel-cage, wound-rotor or synchronous type.

MAXIMUM RATINGS

2300 volts		4600 volts
600 HP	60 cycles	600 HP
300 HP	25 cycles	250 HP

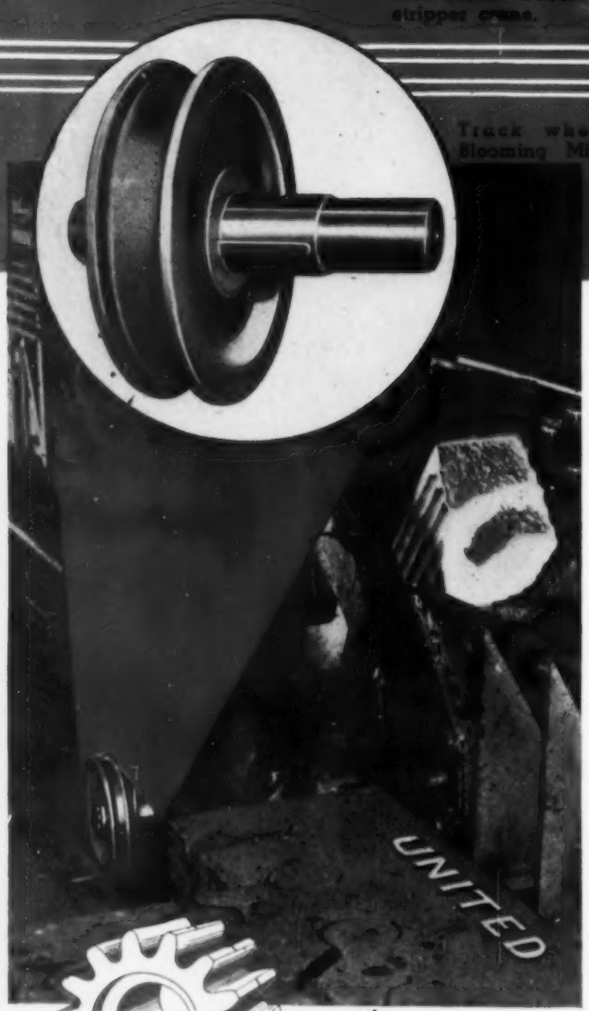
BE SAFE WITH VALIMITOR STARTERS

THE ELECTRIC CONTROLLER & MFG. CO.

2698 EAST 79TH STREET • CLEVELAND 4, OHIO

Track wheels, gears, pinions, and brake wheels on large stripper crane.

Track wheels on Blooming Mill ingot buggy.



"TOOL STEEL" PROCESS

TRACK WHEELS

the standard for long life

Both operators and maintenance men have learned over a period of time that no other track wheels can match the long, continuous service life of "Tool Steel" track wheels!

A "Tool Steel" track wheel installation means literally years of trouble-free life as against an expectancy of months for ordinary wheels, in the same punishing service.

Write today for complete information.

"TOOL STEEL" PROCESS *The Standard of Quality*

for GEARS • PINIONS • SPROCKETS • WHEELS *and other* HARDENED PRODUCTS

THE TOOL STEEL GEAR & PINION CO.

CINCINNATI 16, OHIO, U.S.A.

"BE KIND TO INGOTS" DAY

Comes Every Day in C. F. & I's New Pits

Micromax Control on Salem Pits Helps Accurate, Economical Heating

It's the ingot that matters in soaking pit operation! Salem Engineering Co. is thinking about ingot quality when they design and install a 24-pit battery like this, and recommend controls to regulate operation. Colorado Fuel & Iron Corp. is planning the future of ingots and ingot products when they decide on temperature cycles and set up operating procedures.

These planners have assigned Micromax Controllers to help protect the "interests" of the ingots during the long soaking period. Micromax gives this protection from several angles. Of course, it doles out fuel, in exactly varied amounts to heat the great chunks of steel accurately and uniformly. It preserves correct temperatures, despite the effects of charging, pulling and changes in ambient conditions. But Micromax is also tied into the regulation of combustion and furnace pressure, so that these conditions are held firmly in line during the necessary adjustments of heating rate and soak temperature. Result — every day is "Be Kind to Ingots" Day in the pits, and *the rolling mill is sure of a constant supply of ingots properly conditioned for processing.*

Leeds & Northrup Co., 4942 Stenton Ave., Philadelphia 44, Pa.

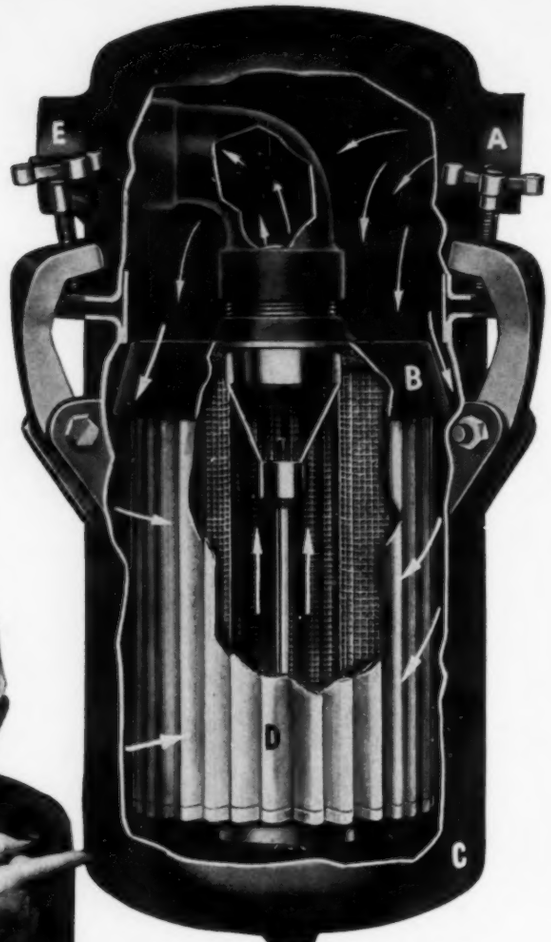
MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

LEEDS & NORTHRUP CO.

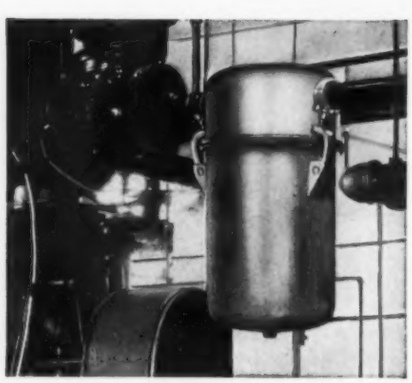
Ird. Ad N-33-667(1)

ELIMINATE VACUUM PUMP REPAIRS

USE STAYNEW VACUUM FILTERS



OPERATION — With filter installed between process and pump, dirty air enters at (A), striking baffle (B). Heavier particles of moisture and dirt are driven to the bottom of shell (C). Passage of smaller dirt particles is prevented by Radial Fin Insert (D). Clean, dry air *only* enters pump from (E).



A Staynew Vacuum Filter installed by a glass bottle manufacturer saved more than twice its cost every year. As a result, in a recent plant expansion, 10 additional Staynew Filters were placed in service to take advantage of these continuing savings.

COSTLY vacuum pump repairs, caused by intake of abrasive material, are unnecessary. Such repairs can be positively prevented at relatively low cost by the installation of Staynew Vacuum Filters.

Today, hundreds of these filters save time and money in the food, glass, ceramic, steel, chemical and other industries.

Featuring the original Staynew Radial Fin Construction, the high efficiency of Staynew Vacuum Filters makes them ideal for laboratory use.

Models available for both wet and dry process pumps. Special materials can be furnished on request.

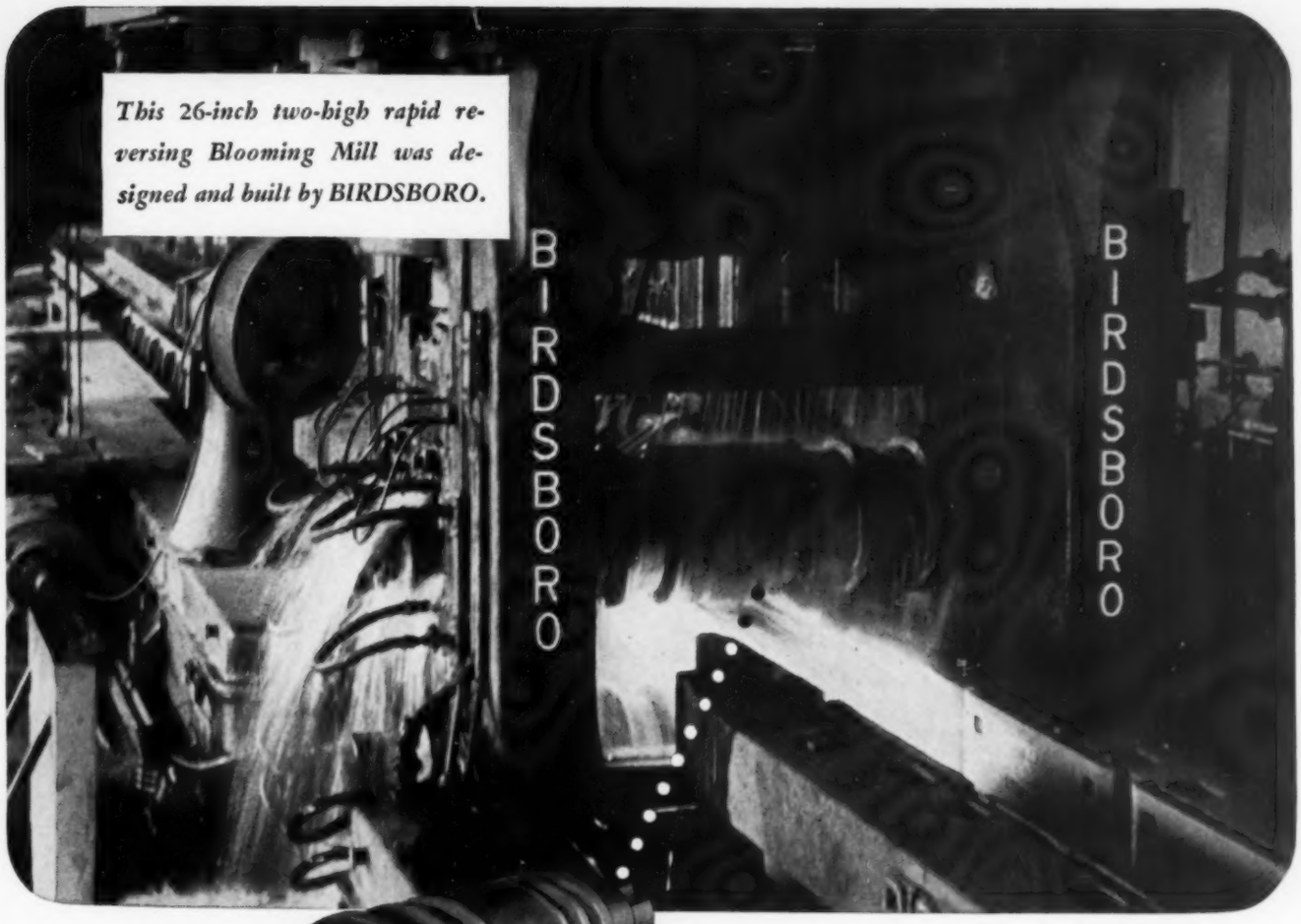
COMPLETE INFORMATION ON REQUEST

DOLLINGER CORPORATION

FILTERS EXCLUSIVELY SINCE 1921

16 CENTRE PK., ROCHESTER 3, N.Y. • REPRESENTATIVES IN PRINCIPAL CITIES

DOLLINGER REG PROTECTOMOTOR U.S. PAT. OFF. STAYNEW FILTERS



This 26-inch two-high rapid reversing Blooming Mill was designed and built by BIRDSBORO.

BIRDSBORO ROLLS

Keep Rolling For High, Continuous Production

There's less downtime to eat up your profits and increase maintenance costs when Birdsboro "40" copper bearing alloy steel rolls are on the job. They are designed and built for

1. GREATER STRENGTH—to withstand higher mechanical stress.
2. INCREASED HEAT RESISTANCE—to reduce fire-cracking and wear.
3. TIGHTER SURFACE GRAIN—to hold "mirror" finishes longer.

Birdsboro's individualized roll service insures you of rolls with the right combination of analysis and physicals to do your specific job. Our engineers would like to discuss your roll problems with you and work out a practical solution to give you highest roll efficiency at minimum cost.

40 BIRDSBORO ROLLS PATENTED

BUILDERS OF: Rolls, Steel Mill Equipment, Hydraulic Presses, Special Machinery, Crushing Machinery, Steel Castings

Birdsboro Steel Foundry & Machine Co. • Birdsboro, Pa.

BIRDSBORO ROLLS

EC&M *TAB WELD GRIDS* designed for efficiency

Widths and Openings matched to ampere and radiation needs . .

Here's why these new *Tab-Weld* Resistors are unmatched in meeting the requirements of control service for crane and mill duty:

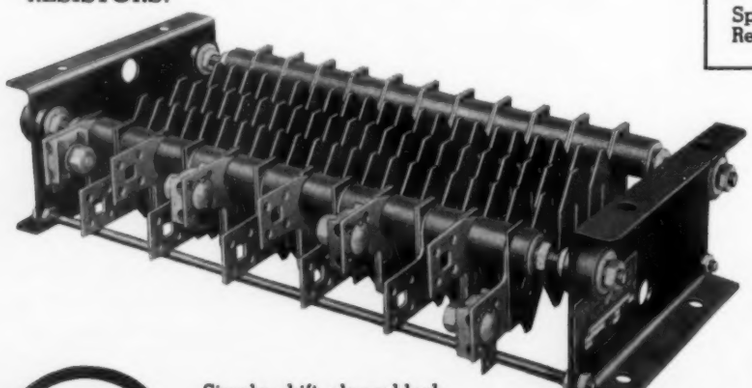
(1) Metal area and cooling surfaces are accurately proportioned for uniform temperature rise throughout each grid.

(2) Spot-welding of mated grid-ends and of taps to grid-ends eliminate burning at the grid eyes and at the taps.

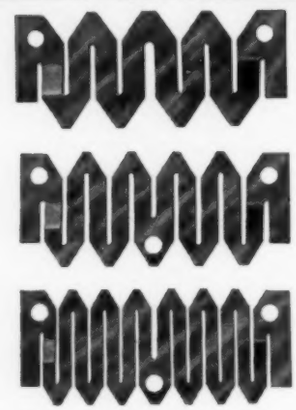
(3) Standard sections have the same size grid throughout the section.

(4) The large number of taps makes internal tap-shifting unnecessary.

For reduced maintenance where maintenance can be easily overlooked, switch to EC&M *Tab-Weld* PLATE RESISTORS.



Simply shift clamp-block for proper resistance.



3 x 3 = 9 grid sizes for wide horsepower range

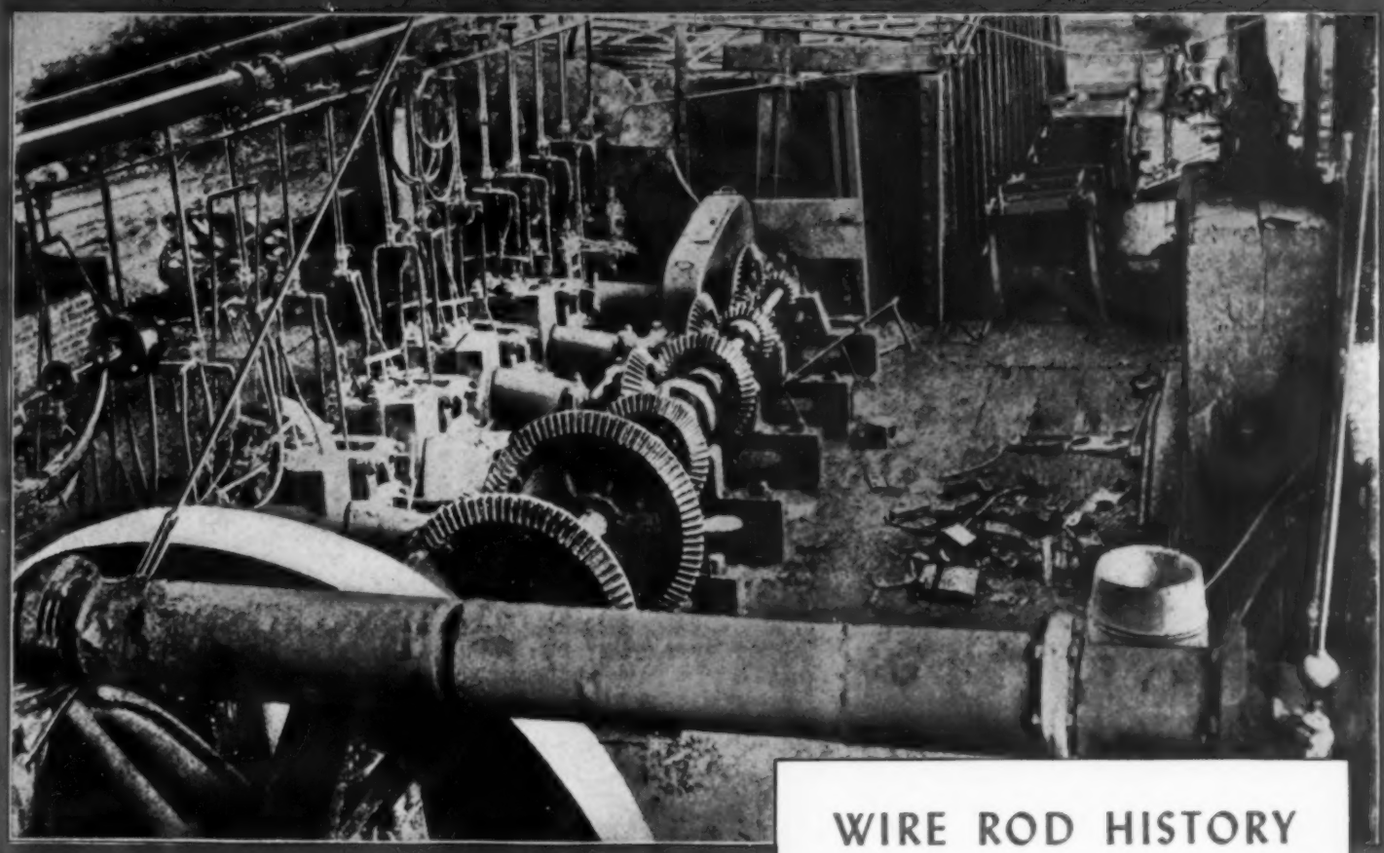
EC&M *Tab-Weld* GRIDS are stamped from corrosion-resistant steel in the above three designs. Three different gauges of steel per design give only nine grid sizes. Assembled in *"standard"* sections, these EC&M *Tab-Weld* Resistors are available in capacities up to 150 amperes without internal paralleling. For larger capacities, external paralleling of complete sections is simplified by the standard tap arrangement of each section.

Specify EC&M Bulletin 942 *Tab-Weld* Plate Resistors for Crane and Mill Auxiliary Control.

Specify EC&M Bulletin 942 Tab-Weld Plate Resistors for Crane and Mill Auxiliary Control

THE ELECTRIC CONTROLLER & MFG. CO.

2698 EAST 79TH STREET • CLEVELAND 4, OHIO



BEDSON WIRE ROD MILL—PATENTED, 1862. USED UNTIL LATE NINETY'S.

WIRE ROD HISTORY

1700 B. C —Earliest known use of wire.

1751 A D —Oliver slitting mill built.

1783—Cort patented grooved rolls.

1839—First wire rod mill in U.S.A.

1842—First continuous wire rod mill.

1860—Crinoline wire and hoop skirts.

1862—Bedson continuous mill patented.

1868—Hunt patented barbed wire.

1882—First Garret rod mill built.

1884—First loom-woven fencing made.

1892—Wire nail production first exceeded cut nails.

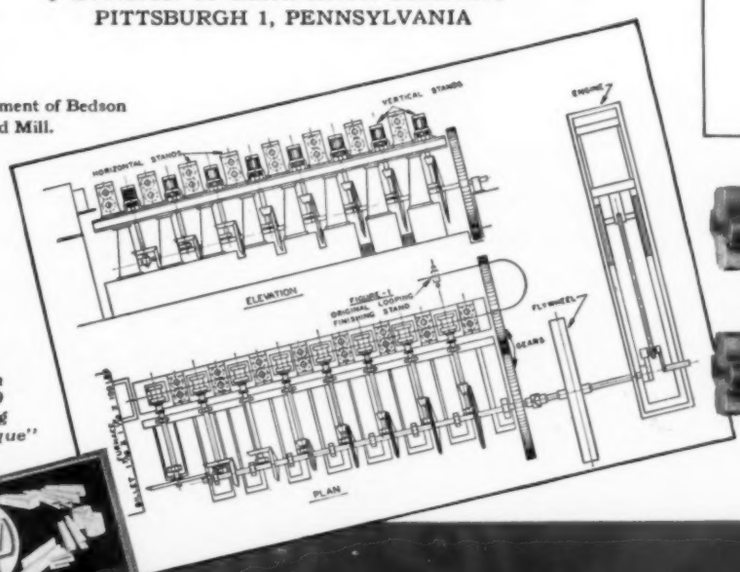
The Wire Rod Mill gave us farm fences, screened homes, and made possible the tremendous development of the electrical age.

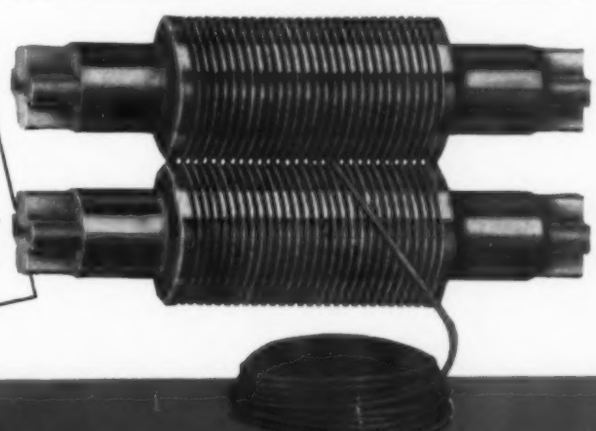
Phoenix Rolls contributed to the development of the modern wire rod mill by giving *more production at less cost per ton of steel rolled.*

PITTSBURGH ROLLS

DIVISION OF BLAW-KNOX COMPANY
PITTSBURGH 1, PENNSYLVANIA

Arrangement of Bedson Wire Rod Mill.





Ask for Bulletin No. 2090 "Rolling Technique"

PITTSBURGH ROLLS

LOOKING FOR *Profit Making Answers* to your METAL WORKING PROBLEMS?

They're in these "Buffalo" Bulletins

-Write for yours!

1

2

3

4

WHETHER you cut billets or drill holes, TIME and ACCURACY are the big factors! That's why it pays to know about the latest advancements in "BUFFALO" machines, and what these machines can do. "BUFFALO" tool engineers work WITH the heavy industries . . . and are continually developing fabrication machines that will do the work faster, more easily, more accurately . . . and at LOWER UNIT COST. If you have a fabrication problem, by all means, get the latest "BUFFALO" answer on it!

BUFFALO FORGE COMPANY

173 MORTIMER STREET BUFFALO, N. Y.

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

1 UNIVERSAL IRON WORKERS These allow three operations to be done at once . . . cutting, punching, slitting, notching, coping of angles, tees, beams, flats, rounds, squares and special shapes accurately and FAST! Write for Bulletin 360 C.

2 MILL TYPE SHEARS Providing open tooling space on three sides, for punching, shearing or blanking, "BUFFALO" Mill Type Shears are available in twelve sizes . . . 250 to 1400 ton capacities. Many unusual features for the heavy industries in these machines, described in Bulletin 3650.

3 BILLET SHEARS In eleven sizes, for round or square billets, these machines produce square, undistorted cuts at a rapid rate for the heavy stock they handle. Many now giving excellent service on grueling 24-hour shifts. Write for Bulletin 3295-A.

4 "RPMster" DRILLS These are the high-accuracy drills with the instant speed selection! Reduces setup time greatly, lowering unit costs on every job. Every shop should know about the "RPMster"! Write for Bulletin 3257.

"Buffalo"

MACHINE TOOLS

PRODUCT *Information*

ON ANY OF THE PRODUCTS MENTIONED IN THIS ISSUE

Below is an index of products referred to in editorial and advertising pages of this issue. If you desire additional information on any of them, use one of the accompanying postcards in requesting it. In each case give name of product and page number. The information will come to you directly from the manufacturer involved.

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IRON AND STEEL ENGINEER
1010 EMPIRE BUILDING
PITTSBURGH 22, PA.

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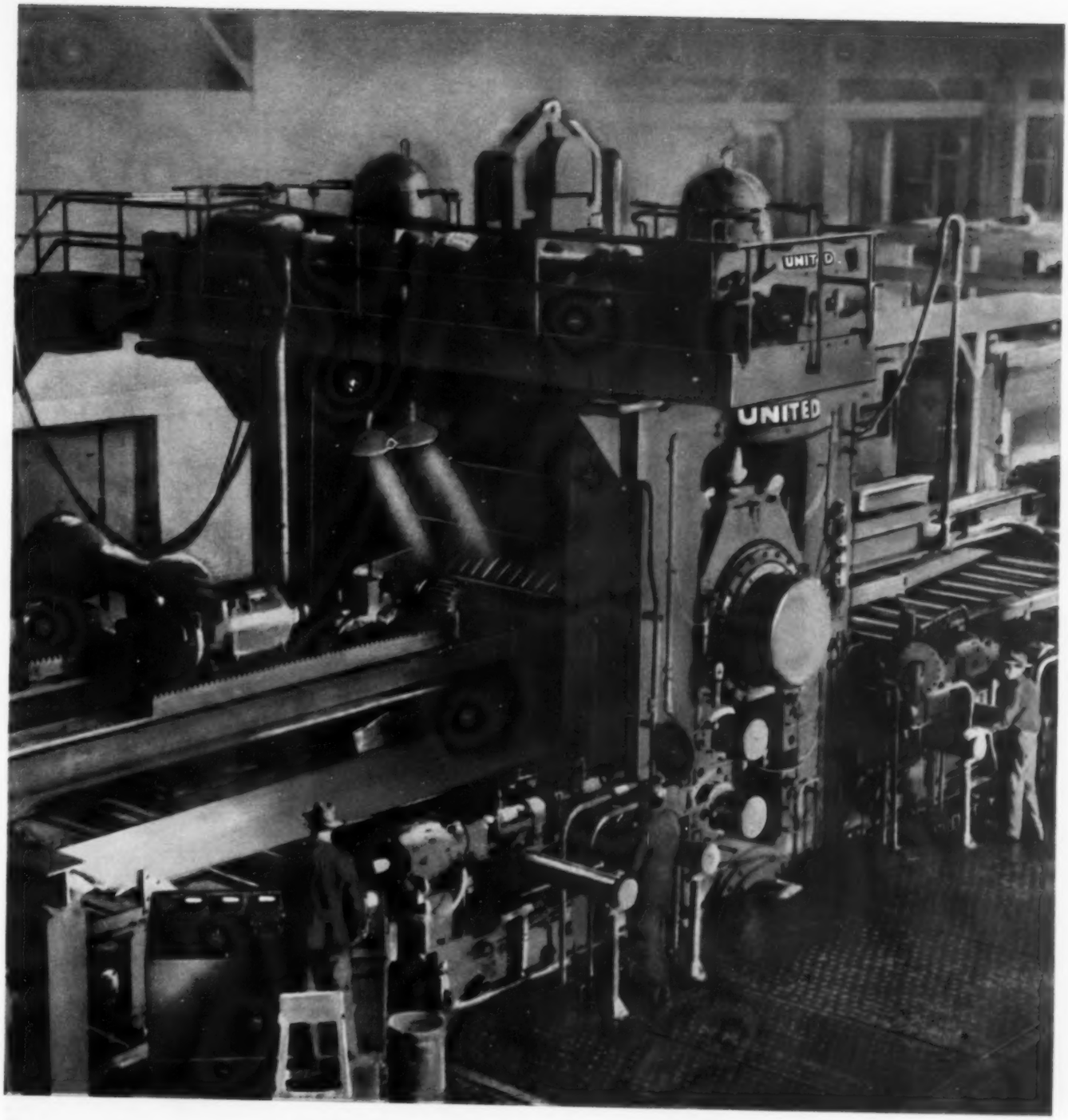


4 High Aluminum Rolling Mill

Designed and Built by

UNITED ENGINEERING and FOUNDRY COMPANY

PITTSBURGH, PENNSYLVANIA

Plants at PITTSBURGH · VANDERGRIFT · NEW CASTLE · YOUNGSTOWN · CANTON

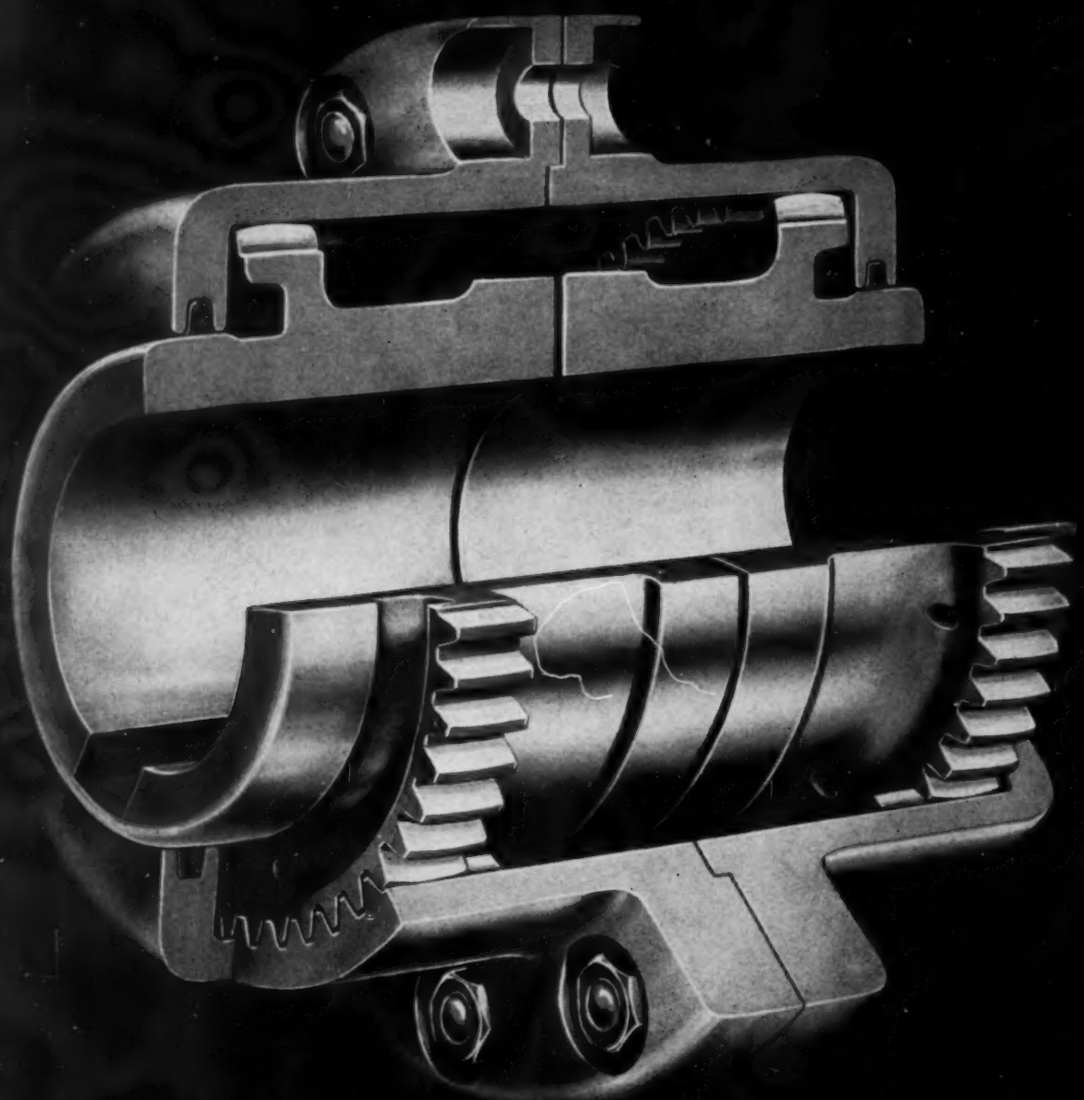
Subsidiary: Adamson United Company, Akron, Ohio

Affiliates: Davy and United Engineering Company, Ltd., Sheffield, England

Dominion Engineering Works, Ltd., Montreal, P. Q. Canada · S. E. C. I. M., Paris, France

Designers and Makers of Rolls and Rolling Mill Equipment

POOLE



A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

FLEXIBLE COUPLINGS

POOLE FOUNDRY & MACHINE COMPANY

WOODBERRY, BALTIMORE, MD.

Ohio Rolls

SHAPING METAL FOR ALL INDUSTRY

MEET PRODUCTION DEMANDS

More, more, more . . . in less time . . . is the steel business today. Meet and beat demands with Ohio Rolls. Get greater tonnage at lower cost. Ohio Rolls give you a production advantage.

Select from any of these eleven types of Ohio Steel and Iron Rolls: Carbon Steel Rolls, Ohioloy Rolls, Ohioloy "K" Rolls, HOLL-O-CAST Rolls, Chilled Iron Rolls, Alloy Chilled Iron Rolls, Denso Iron Rolls, Nickel Grain Rolls, Special Iron Rolls, Nioloy Rolls, Flintuff Rolls.

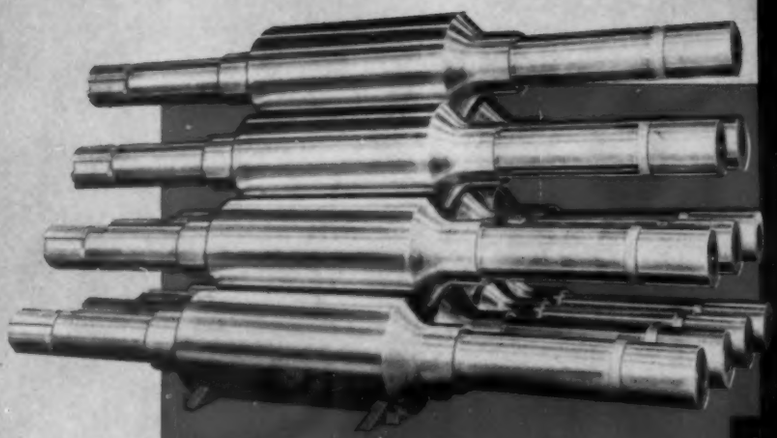
THE OHIO STEEL FOUNDRY COMPANY—LIMA, OHIO

PLANTS AT LIMA AND SPRINGFIELD, OHIO

Rolls and Pinions

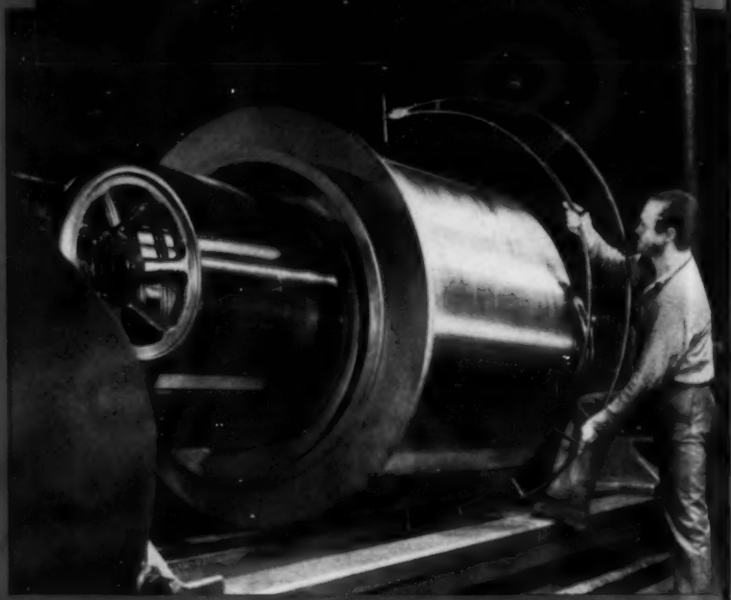
Designed and Built by

MESTA

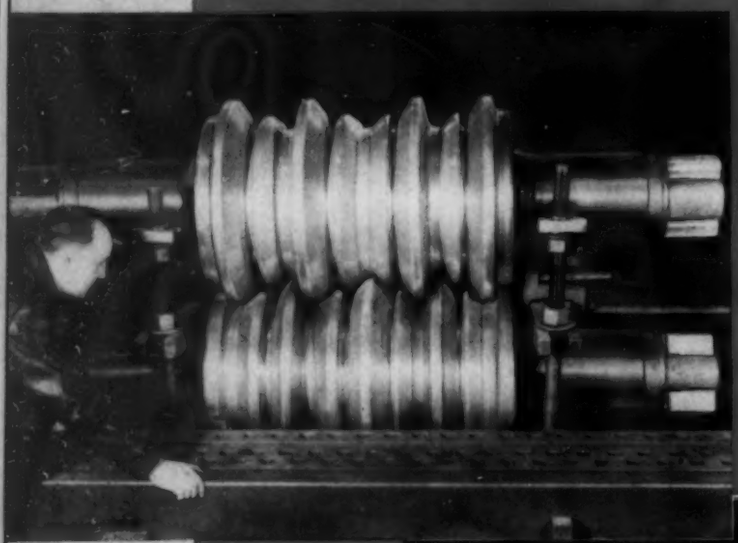


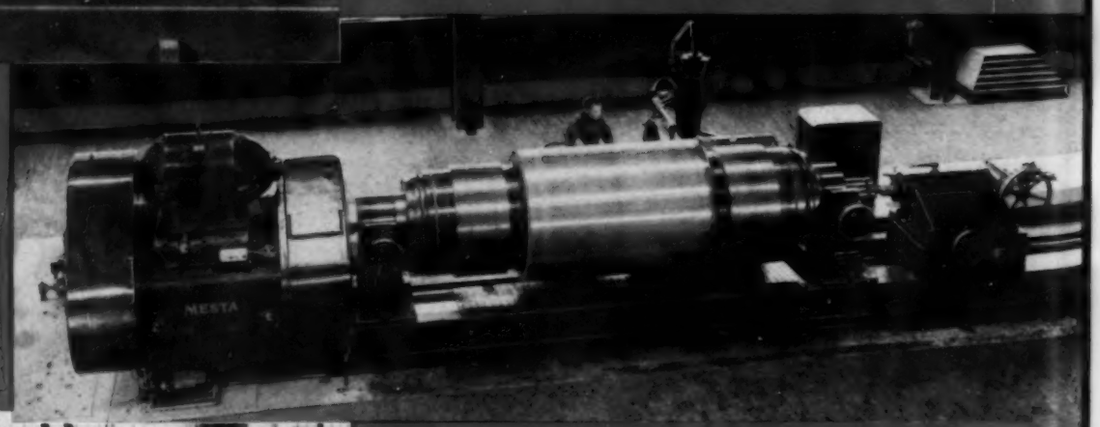
Group of Forged Hardened Electric Steel Working Rolls for Cold Reduction Mills

A pair of Mesta Merchant Mill Rolls for the production of I-Beams

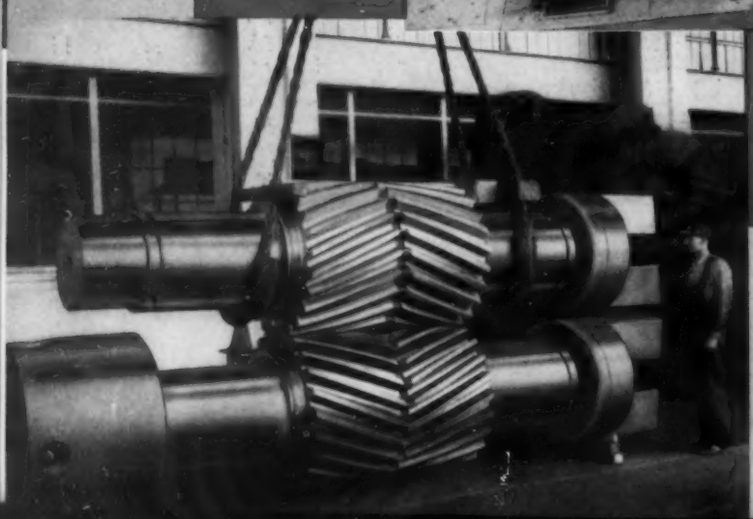


Mesta 56" diameter Special Alloy Cast Steel Backing-Up Roll for a modern high speed Four-High Cold Reduction Mill





Mesta 60" Heavy Duty Traveling Wheel Head Type Roll Grinder

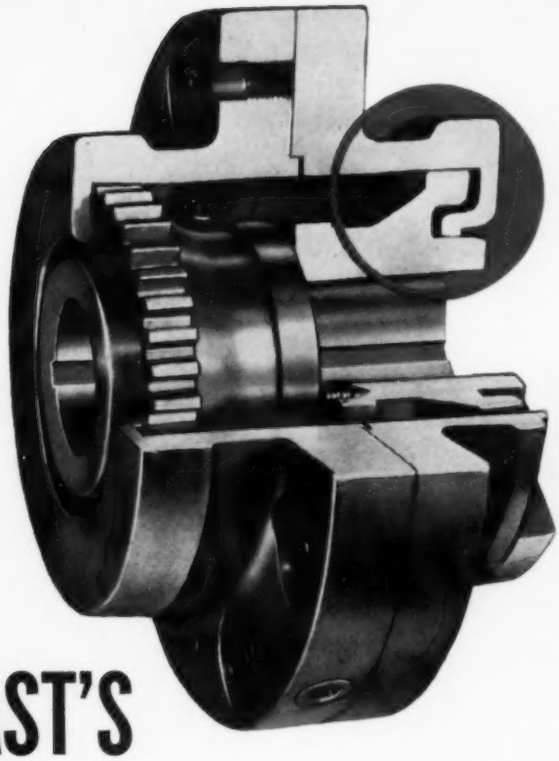


38" x 54" Forged Steel Blooming Mill Pinions
Mesta also produces Cast Steel Mill Pinions with cut or molded teeth

Designers and Builders of Complete Steel Plants

MESTA MACHINE COMPANY

PITTSBURGH, PA.



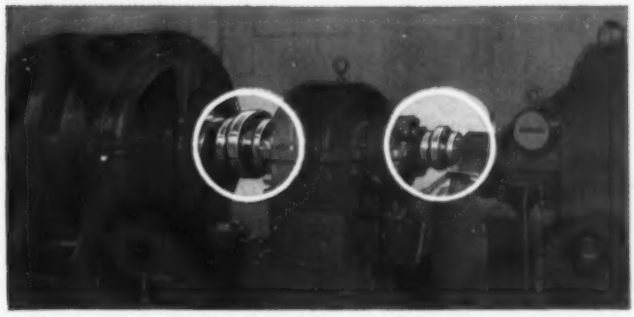
FAST'S

ALL-STEEL Construction Gives NON-STOP Power Transmission!

These installations have an important feature in common. They're all protected against coupling shutdowns by Fast's self-aligning Couplings. That's because these original gear-type couplings are all-steel throughout, *without perishable parts!* Even the load-carrying oil is protected by an *exclusive* "rocking bearing." This bearing is *exclusive* in providing a positive metal-to-metal seal which keeps out moisture, dust and grit. The bearing is also *exclusive* in its correctly engineered position which allows *freedom of movement* to compensate for misalignment because its *spherical* base has *the same axis* as the hub spline faces. No perishable packing rings are used in this vital spot.

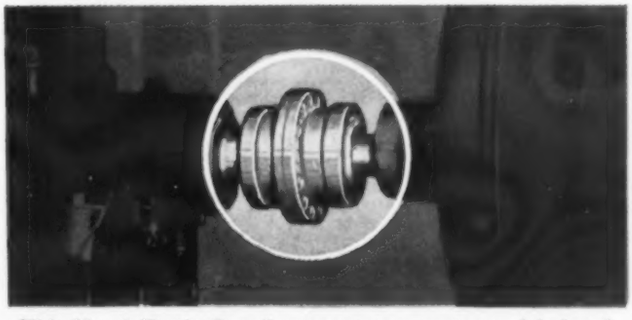
We have a complete line of couplings for immediate delivery. No matter which type of Fast's Couplings you buy, you get the benefits of years of top engineering experience, Koppers' high standards of workmanship and unexcelled coupling service which assure you of spare parts no matter how old your couplings may be. That means non-stop power transmission, longer machine life, lower costs, minimum shutdown losses! Koppers Co., Inc., Fast's Coupling Dept., 311 Scott St., Baltimore 3, Maryland.

Fast's Coupling connects 1,800 h.p., 600 r.p.m. motor to 30 million-gallon-per-hour pump at City of Montreal pumping station.



These No. 3 and No. 5 Fast's Couplings connect a turbine-reduction gear-generator hookup, 1125 h.p. at 3740/1200 r.p.m., at Firestone Steel Products Co., Akron, Ohio.

This group of Fast's Couplings has been giving trouble-free service since 1922 at the Western Maryland Dairy Company's Baltimore plant.



This No. 4 Fast's Coupling connects a motor and induced draft fan at the West Penn Power Company's Beach Bottom, W. Va., plant.

K KOPPERS

FAST'S *self-aligning* COUPLINGS

SEND FOR FREE CATALOG giving detailed descriptions, engineering drawings, dimension and capacity tables and typical installation photographs for the many types of Fast's Couplings. Fill out this coupon and mail it to: Koppers Co., Inc., Fast's Coupling Dept., 311 Scott St., Baltimore 3, Md.

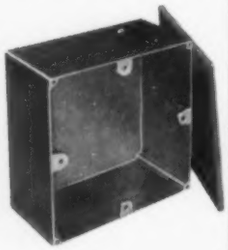
NAME.....POSITION.....

COMPANY.....

STREET .....CITY.....STATE.. ..

O.Z. cast iron boxes

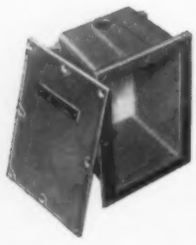
COMPLETE LINE • COMPLETE LINE • COMPLETE LINE COMPLETE LINE



TYPE YI200
Unflanged junction box with cover. Flush or Surface mounting.

TYPE Y3200
Weatherproof pull box. Complete with one-piece rubber gasket and hinged cover; surface mounting.

TYPE Y6000
Explosive resisting junction box designed in accordance with Underwriter's Laboratory requirements. Cover and flange are accurately machined and correct bolt spacing provided. Flush or Surface mounting.



TYPE Y8000
Flanged watertight box with cover complete with rubber gasket. Flush or Surface mounting.

5214

When you specify O. Z. Cast Iron Boxes for industrial, railroad, airport, oil refinery and other heavy-load circuits, you specify the best. Cast from close-grained, grey iron, these sturdily constructed boxes are accurately machined to your requirements and then hot-dip galvanized to provide maximum corrosion resistance.

No matter what the operating condition . . . explosion resisting, watertight or weatherproof . . . you'll find a box to fit the job in O. Z.'s complete line. All boxes can be supplied with or without bosses or mounting lugs and are drilled for conduit entrances as required.

For detailed information on O. Z.'s Cast Iron Boxes as well as 150 other electrical fittings, write for our catalog.

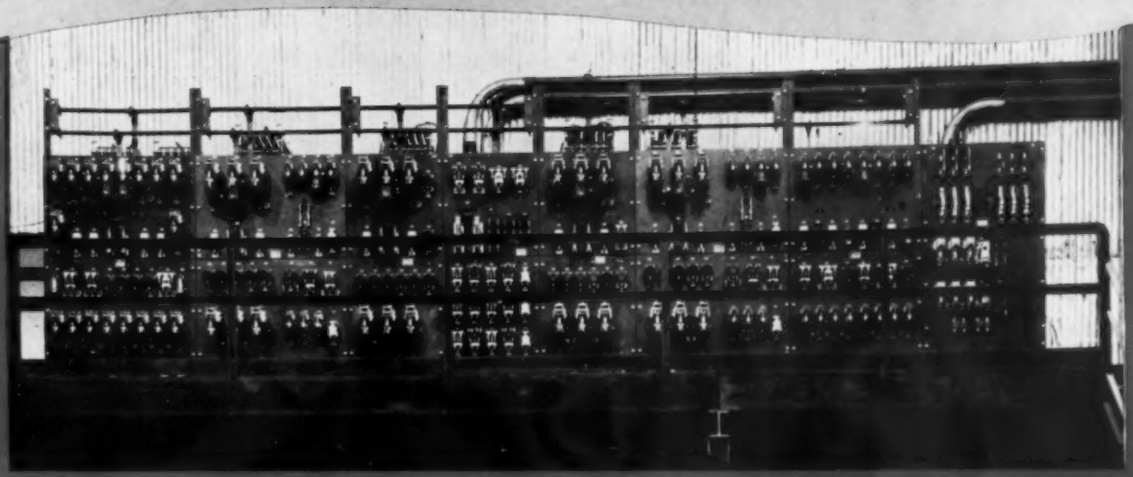
- CAST IRON BOXES
- SOLDERLESS CONNECTORS
- CONDUIT FITTINGS
- CABLE TERMINATORS
- GROUNDING DEVICES
- POWER CONNECTORS

Buy O.Z. and you'll see why Engineers say,

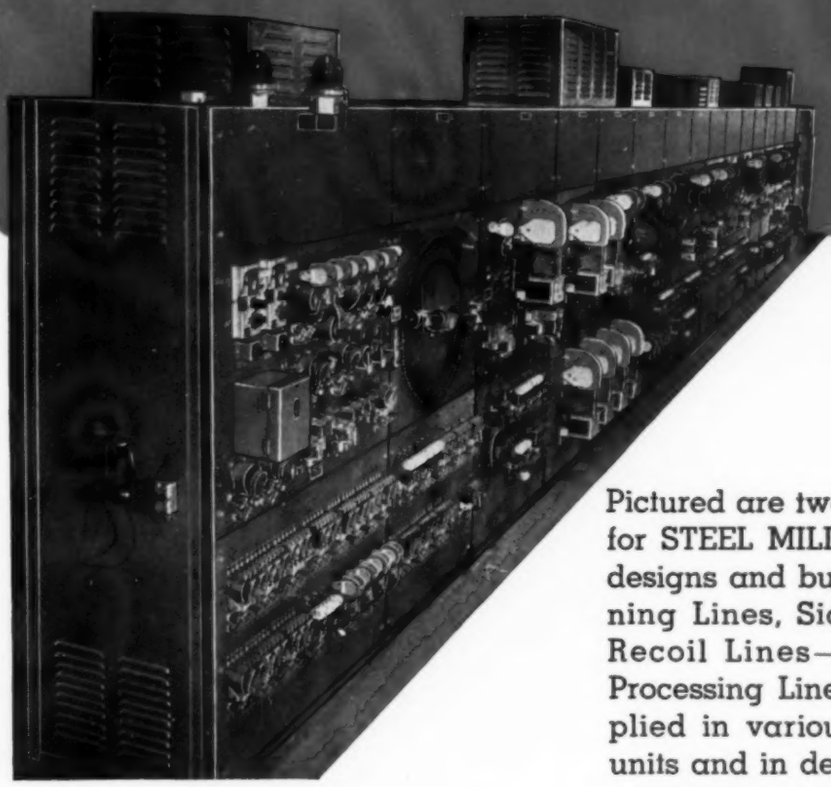
"They're OK If They're O.Z."

O.Z. ELECTRICAL MANUFACTURING COMPANY, INC.
262 BOND STREET · BROOKLYN 2, N. Y.

For every STEEL MILL Processing Line there's a CLARK control



Clark Factory Assembled Control for Hot-Coil Conveyor, 80" Hot Strip Mill



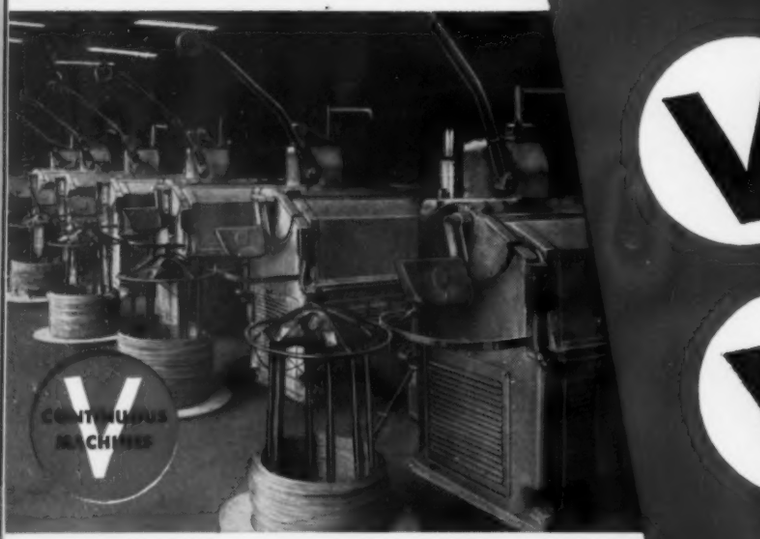
Factory Assembled Clark Control for 56" Pickle Line

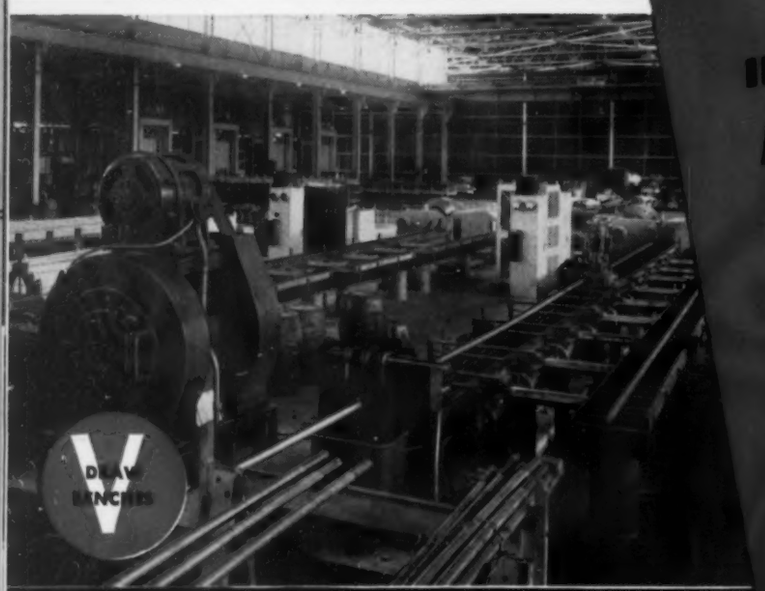
Pictured are two typical CLARK control panels for STEEL MILL processing lines. CLARK also designs and builds control for Electrolytic Tinning Lines, Side Trimmers, Shearing Lines, Recoil Lines—in fact every type of Steel Processing Lines. These controls may be supplied in various types of factory assembled units and in dead-front cabinets. A full line of accessories, such as Brakes, Master Switches, Push Buttons, Foot Switches and Limit Switches, is also available.

Consult CLARK on your Steel Mill Processing Line Control Problems

THE CLARK CONTROLLER CO.

EVERYTHING UNDER CONTROL • 1146 EAST 152nd STREET, CLEVELAND 10, OHIO





Vaughn means Value—

in every COLD DRAWING MACHINERY application!

Vaughn Cold Drawing Machinery returns consistent profits on your investment through values that are integral with the equipment: Speed, Versatility, Flexibility, Durability! Let us translate these advantages in terms of your specific production problems.

"Quick on the Draw!"

VAUGHN MACHINERY

PROFITABLY USED BY LEADING WIRE MILLS SINCE 1871

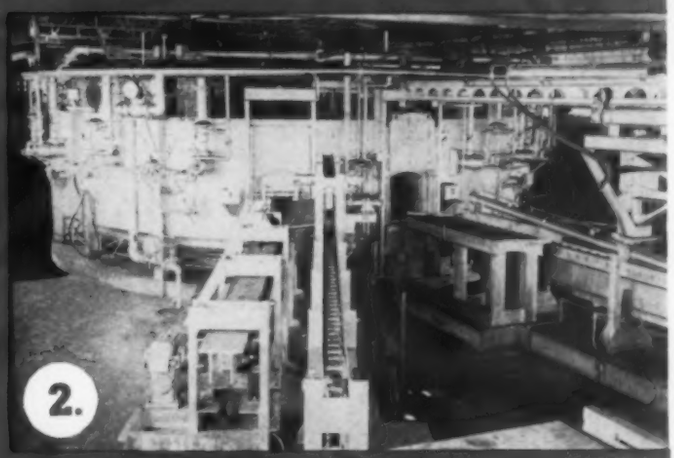
THE VAUGHN MACHINERY COMPANY

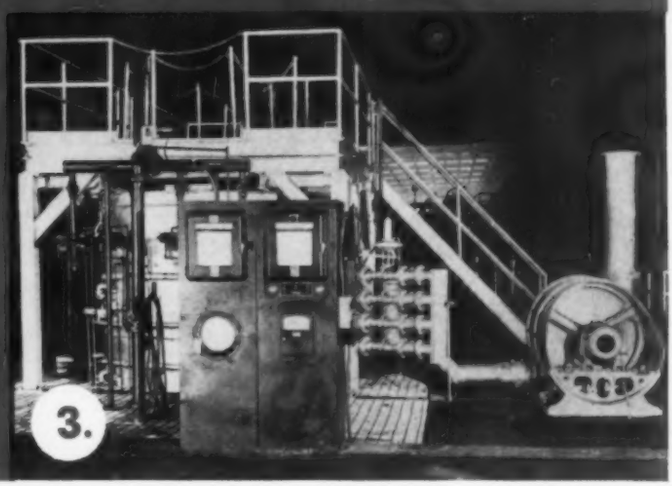
CUYAHOGA FALLS, OHIO, U. S. A.

COMPLETE COLD DRAWING EQUIPMENT — Continuous Rod Straightening Machines — Wire Drawing Capstans

SALEM

ENGINEERS AND BUILDS ALL TYPES OF FURNACES AND EQUIPMENT FOR THE INDUSTRY





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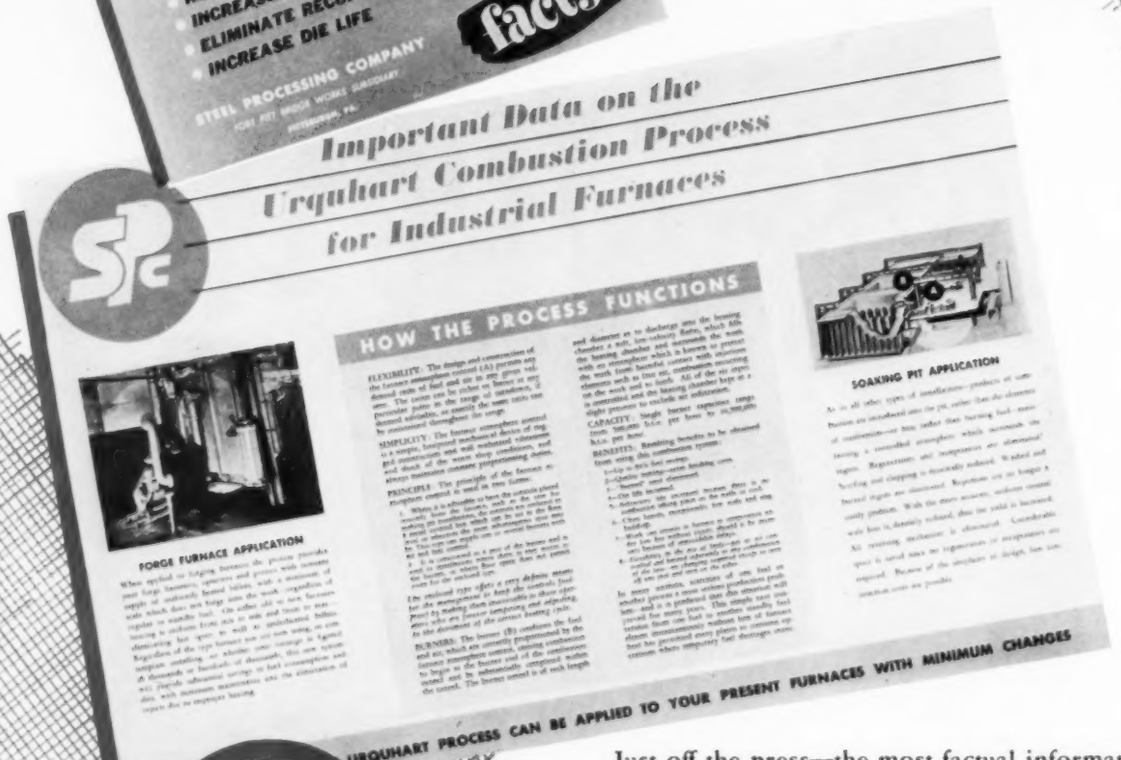
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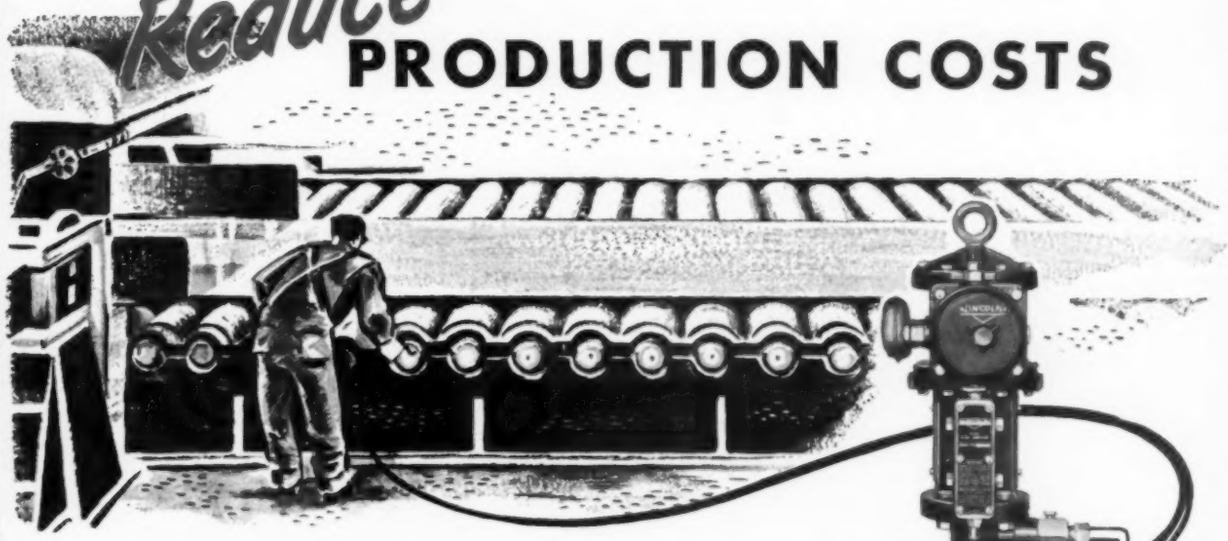

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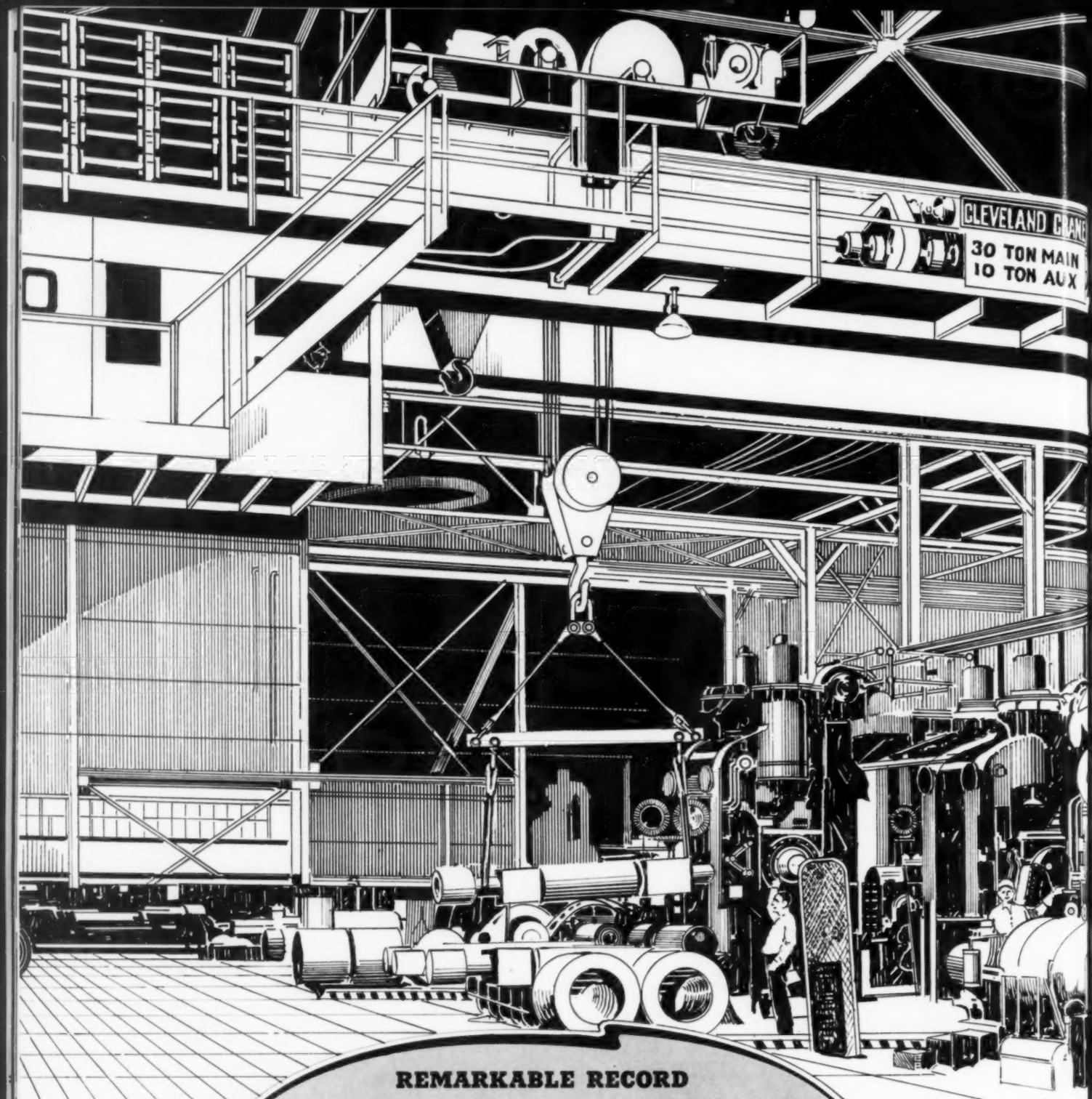

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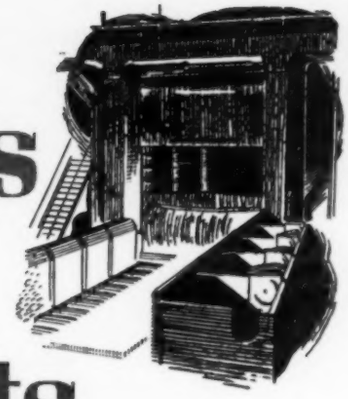


WHEN the steel industry went off the basing-point price system, surmises were rife concerning probable locations for new steel plants close to the steel consuming centers. Some such moves are still possible, but so far it has been the consumers who are making the moves toward the steel producing centers. The announcement by General Motors Corporation of preliminary steps to put two automobile body plants in the Pittsburgh district is perhaps the most important to date. It is generally felt that other similar moves are pending, but have been awaiting some indication as to possible future government action on the basing point system.

Meanwhile, steel makers in general give no indication of plans to move. On the contrary, expansion of existing plants goes on in every section of the country. Pittsburgh, thought by some to be a possible sufferer from f.o.b. mill prices, is the scene of general expansion. Most recent is the announcement by Jones and Laughlin Steel Corporation of a new $70,000,000 expansion project (discussed elsewhere in this issue) at their Pittsburgh works. United States Steel Corporation is continuing expansion and rehabilitation of its various properties. Likewise, Allegheny-Ludlum Steel Corporation, Crucible Steel Company of America, and Pittsburgh Steel Company are all spending substantial sums in the Pittsburgh district.

Steel producers in general seem to feel that the advantages of the Pittsburgh district are sufficient to keep them in a competitive position.

▲

WITH election hullabaloo over — to the dire confusion of opinion polls and political experts — we can all go back to work, with the fervent hope that the unity required by the international situation will prevail.

▲

BUT it just goes to prove the truth of President Truman's statement: "It isn't important who is ahead at one time or another in either an election or a horse race. It's the horse that comes in first at the finish that counts."

▲

SOME indication of a fourth round of wage increases is given by the American Federation of Labor's recent statement that wages are still lagging behind prices. The union, however, feels that continuation of the wage-price spiral will benefit no one, but that management should cut costs so that wages can be increased without material price increases.

We wonder if they've thought of a better day's work from everyone as a means of cutting costs.

AT the risk of being confused with Broadway columnists, we would like to recommend, for the benefit of our traveling friends, the source of two very good dinners during a recent New York trip: Reuben's, at 6 East 58th Street, and Danny's Hideaway, at 151 East 45th Street.

▲

THE overall construction program of the steel industry is at present estimated to total approximately $1,700,000,000. This is about 25 per cent of the cost of all of the industry's existing facilities, although representing only four or five per cent of existing capacity.

▲

WITH new automobiles exceeding 6 ft in width and shrinking toward 5 ft in height, a lot of us are going to need some way to turn the car on its side to get it in the older garages.

▲

INDUSTRY in general has been forced to borrow from banks or government in order to finance new plant construction. The new expansion of McClouth Steel Corporation, composed of electric furnaces, soaking pits, a blooming mill and finishing facilities at Trenton, Michigan, has somewhat different financing. Of the total investment of $18,500,000, $8,000,000 is coming from the company's customers, with the balance from R.F.C. There are probably a lot of steel users who would be glad to help finance new steel plants.

▲

IN spite of a severe shortage of cement, exports of that material to Europe continue under the Marshall plan. And now comes news that imported German-made cement is being offered for sale in this country. As we've always said, we're not an economist, but . . . !

▲

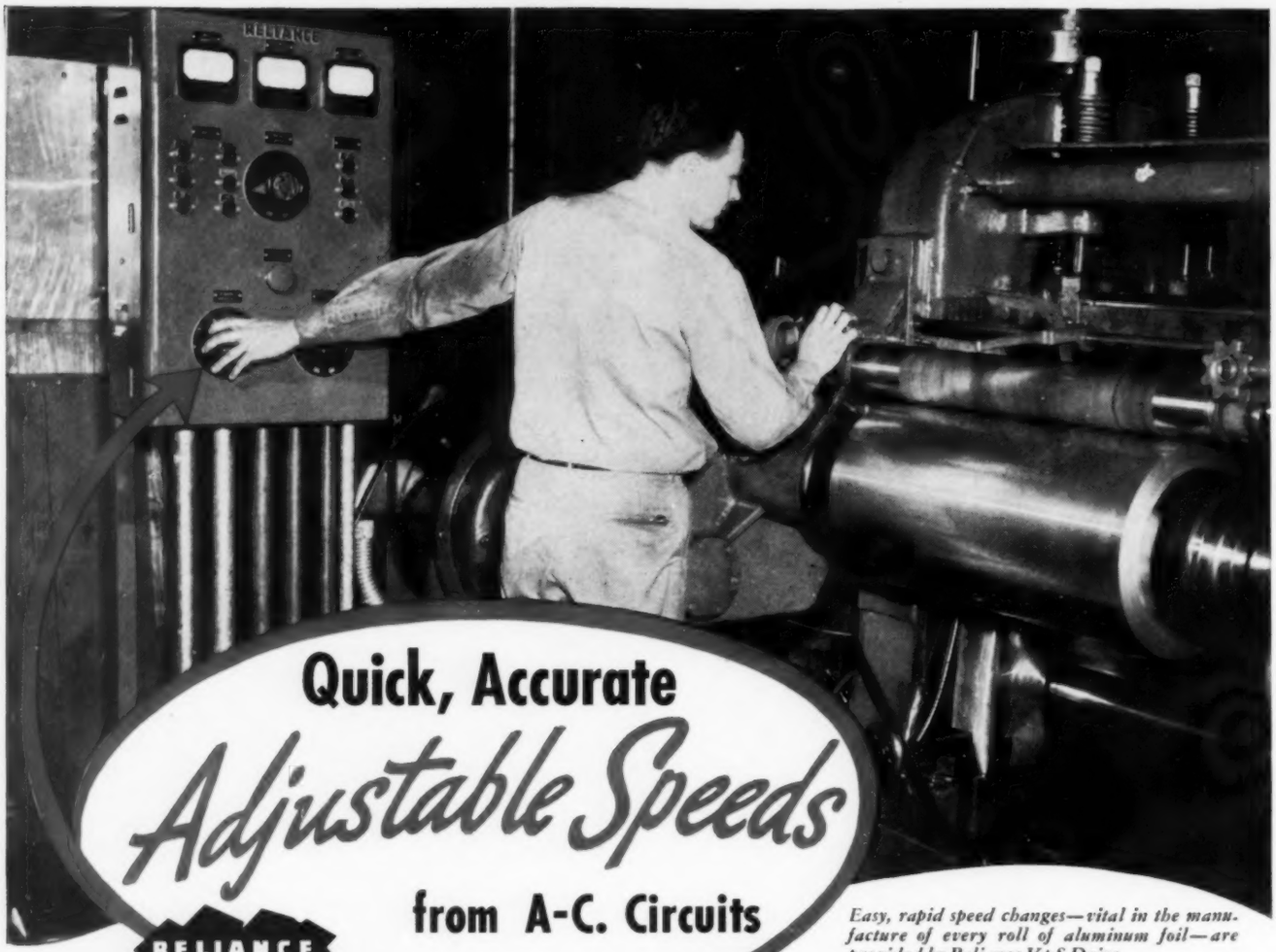
NATIONALIZATION of the British steel industry has started with a bill in Parliment proposing an Iron and Steel Corporation of Great Britain to take over 107 companies at a cost of $1,200,000,000. This includes approximately 96 per cent of the steel production capacity of the country, with its various subsidiaries. The bill provides that nationalization cannot come before May, 1950, and there is hope that a general election shortly after that time might still stem the tide. After our recent experience in the United States, perhaps our British cousins shouldn't put too much hope in elections.

▲

From the Expositor:

I sent my boy to college
With a pat upon the back.
I spent ten thousand dollars
And got a quarterback.

We can't help but add that he must not have been a really good quarterback or he would have brought $10,000 back with him.



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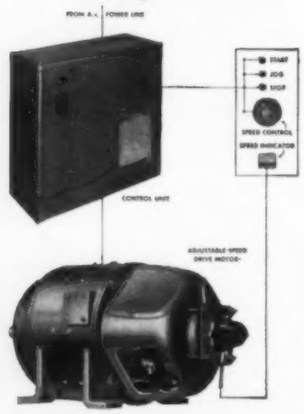

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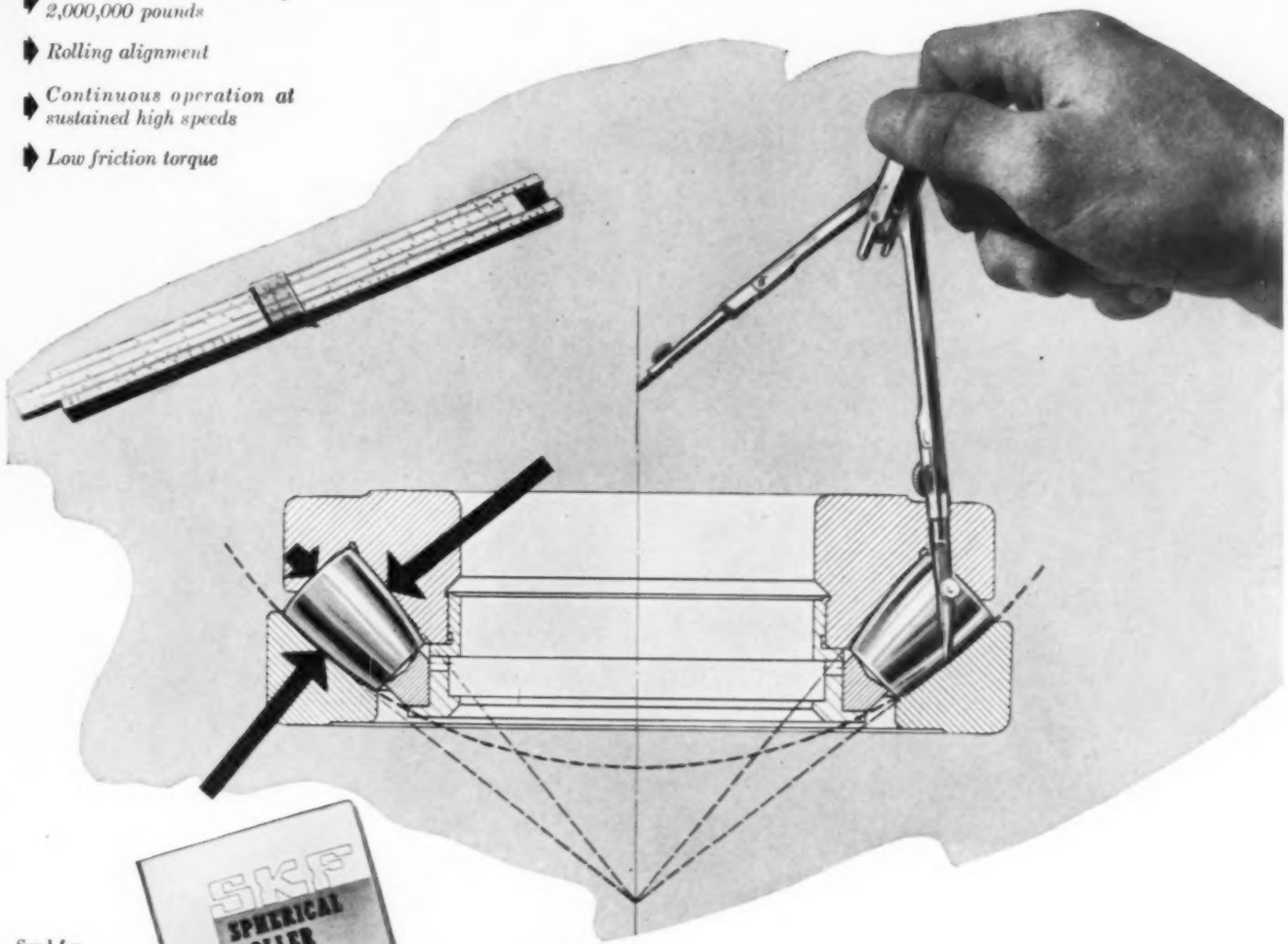

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The rollers are so shaped that load components firmly contact the roller ends against the unusually high guide flange. This assures positive guiding of the rollers without excessive pressure on the roller ends.

The bearing is so constructed that oil is pumped outwardly between the rollers, bathing all parts of the bearing in lubricant. 6454

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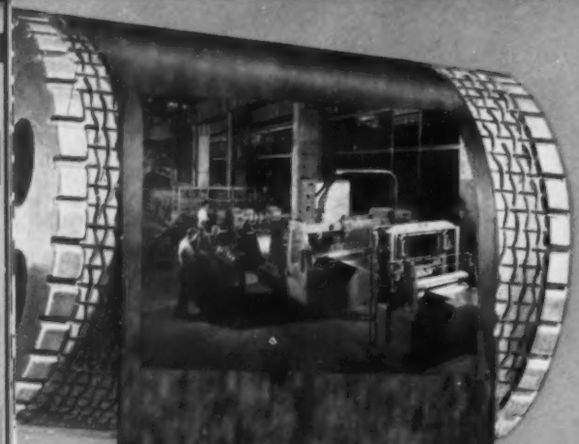

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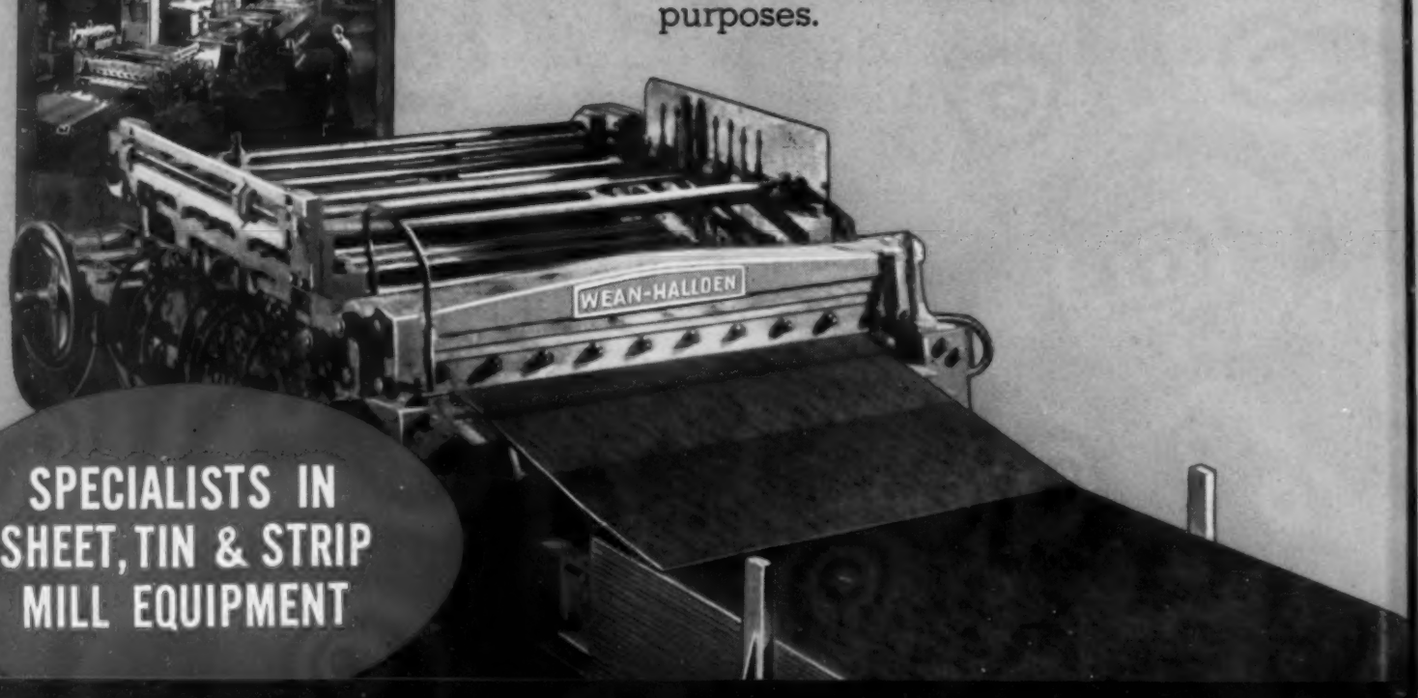

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Iron and Steel ENGINEER

NOVEMBER, 1948 VOLUME XXV NUMBER XI

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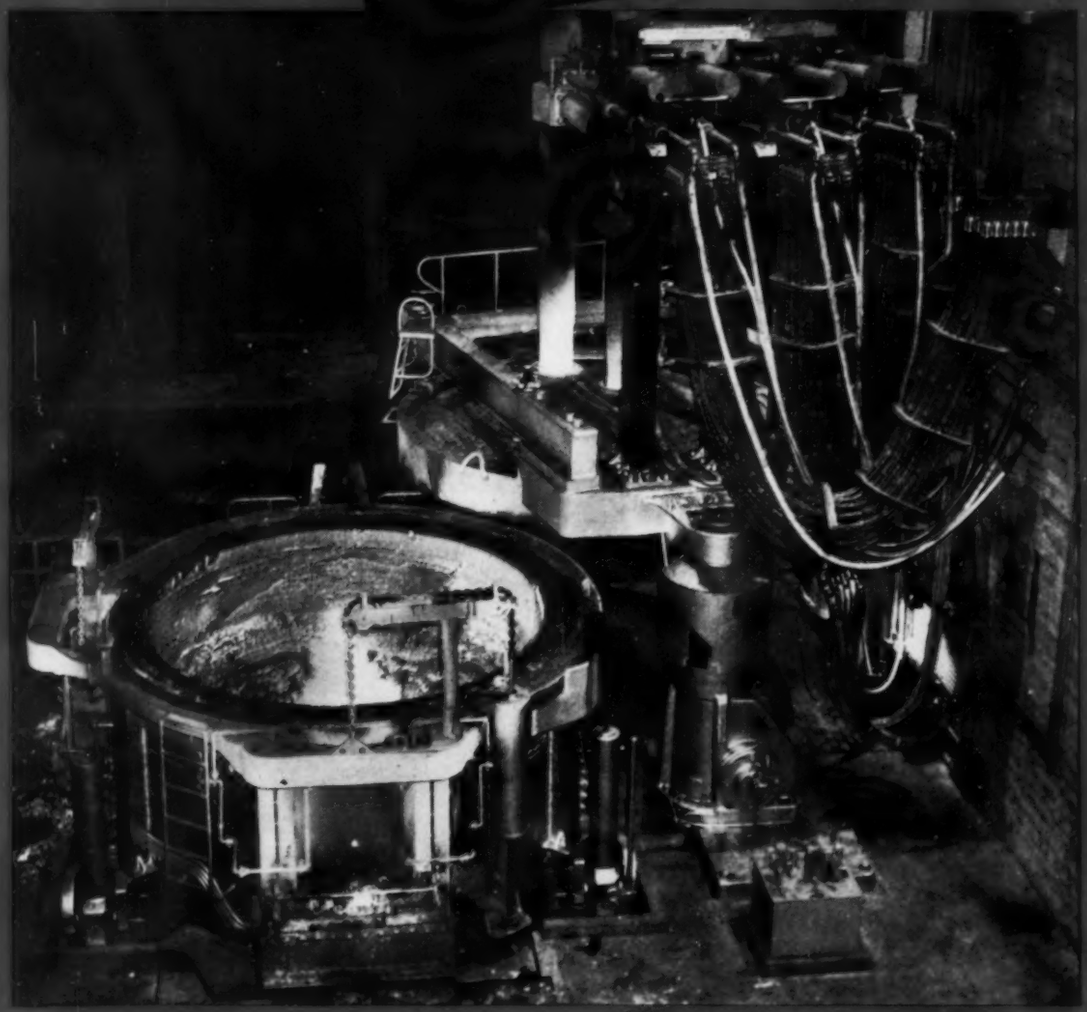

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New Cold Mill at Weirton

INCREASES TIN PLATE CAPACITY

By C. J. KLEIN, Chief Engineer
Weirton Steel Company
Weirton, West Virginia

C. J. KLEIN

. . . . the first mile-a-minute strip mill, built for the Weirton Steel Company, required the solution of many engineering problems to take full advantage of the speed of the mill . . . .

▲ THE product of Weirton's new No. 6 five-stand tandem cold strip mill is primarily tin mill coils in gages from 38 (0.0060 in.) to 29 (0.0135 in.) and in widths up to 38 in., also sheet mill coils in gages from the lightest to about 0.025 in. thick and in widths up to 38 in. A small amount of the capacity rolled is processed in the strip steel department for general purpose items. The coils have an inside diameter of 16½ in. and a maximum outside diameter of 72 in. The weights, depending on width, range up to a maximum of 32,000 lb. The mill has a capacity for rolling 45,000 tons per month.

The major end product of this mill is tin plate, the coating being applied either by the long-used method of hot conveying sheets through molten tin, or the modern electrolytic deposition method of applying the coating from solid tin anodes onto a continuous strip. No other steel mill product is handled so extensively—viewed with such scrutiny by the general public—serves its purpose so quickly and efficiently—and is then discarded—as is a tin can.

The minor end products are tin mill black plate which is shipped uncoated to customers, and sheet mill coils which are mainly processed into galvanized sheets.

The cold rolling of light gage strips for the production of sheet and tin mill products is just one in a large group of operations to provide a finished product. It may be well to briefly review the operations from raw material to finished product such as is done by Weirton and which in general applies to the steel industry.

The materials include in the major part—iron ore, coal, limestone, steel scrap, sulphuric acid, tin and fuels. Coal is received from the mine by barge on the Ohio River and is conveyed to the coal storage bins at the coke ovens.

Coke which is produced in the by-product ovens is used in the blast furnaces for the production of iron. Iron ore which is delivered to the ore storage pile by rail is placed in the blast furnace with coke, limestone, etc., the product resulting therefrom being iron and slag. The hot iron is delivered to the open hearth department and together with properly graded steel scrap is refined into specified analyses of steel to suit the customers' requirements. The hot steel is tapped in 200-ton ladles and then poured into ingot molds of a predetermined size. The ingots are then delivered to the blooming mill department where they are heated, reduced in size to a slab, and then cut to the length required for handling on the hot strip mill. A thorough inspection of the slab surface is made and defects are removed. The slabs are delivered to the hot strip mill department and charged into continuous heating furnaces as required. The properly heated slabs are discharged onto a roughing mill approach table and delivered to the first of four horizontal roughing train roll stands which include three sets of vertical edgers. The average slab thickness is 5¼ in. and the length 12 ft 6 in. The strip delivered from the fourth stand is about ¾ in. thick and 87 ft 6 in. long. The strip now enters a scale breaking stand for surface conditioning which is followed by six stands of four-high rolls and emerges from the finishing stand at a thickness of about 0.090 in. and 730 ft long.

The strip is delivered to one of two coiling units. The coils are deposited onto cooling conveyers for reducing the temperature prior to the pickling operation. In order to provide a clean surface on the hot rolled band prior to cold rolling, it is necessary to pickle the strip in a sulphuric acid solution—this being done continuously.

Presented before AISE Pittsburgh District Section Meeting, May 10, 1948

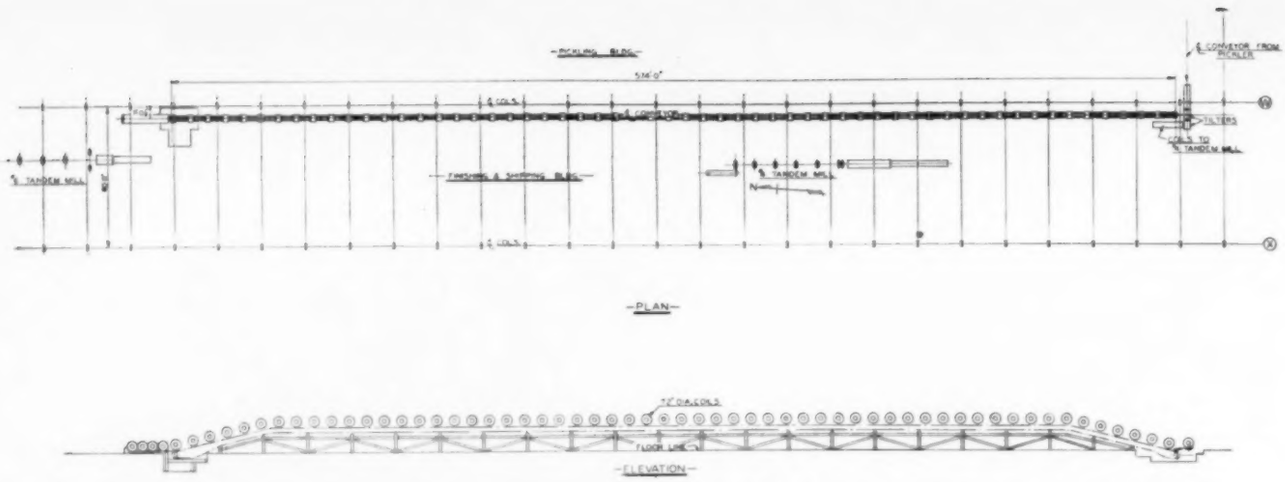


Figure 1 — The conveyer, which conveys the coils from the pickler to No. 6 tandem mill, is 575 ft long.

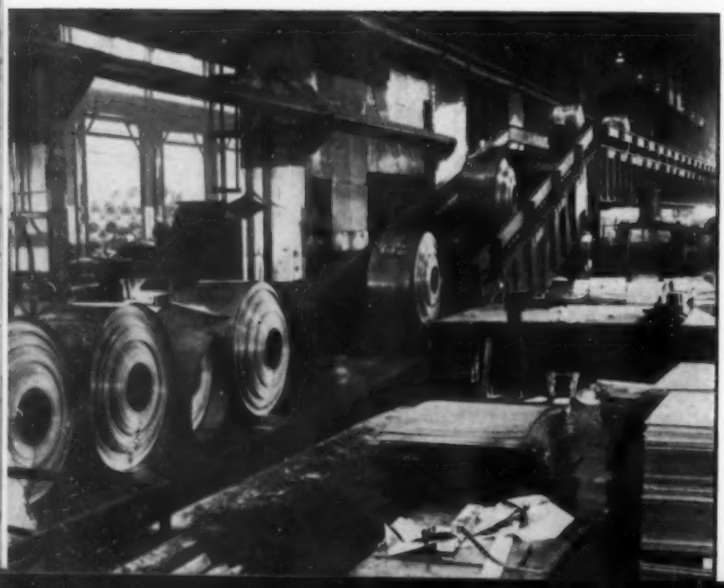
During this operation the coils are butt welded together to provide a size of coil suitable for future processing. From two to five hot mill coils are required in this case. Side trimming of the coils after pickling and in the same operation can be done to provide the best possible band for cold rolling. An application of palm oil is made to both sides of the band prior to coiling at the end of the pickle line which assists in the cold reducing of the band.

The hot rolled and pickled coils coming from any of three lines can be conveyed to any of the entry ends of the cold mills. In the case of the new No. 6 mill an overhead conveyer 575 ft long and capable of holding sixty 32,000-lb coils is provided. This provides a maximum storage of 960 tons of coils for the mill which can be delivered faster than mill requirements.

After passing through the four or five-pass stand cold mills the strip emerges having an average thickness of 0.0093 in. for tin mill products.

The coils are now delivered to cleaning lines where the oil which was required to provide lubrication for the cold rolling of the strip is thoroughly removed. Cold rolling of the strip imparts a hardness to it which makes it impractical for final use, and in order to correct this condition, the coil is annealed bringing it to a dead soft state. Due to the fact that a given required hardness cannot be obtained in the annealing cycle, it is desirable to anneal to a softer state than required and then skin or temper pass the strip on a cold rolling unit to the required hardness. This operation is performed on a two-stand tandem mill. If the black plate is to be processed into hot dipped tin plate it is now cut to size with flying shears, piled and delivered to the white pickler, pickled, placed in water boshes and placed in front of the coating units ready for coating, or taken directly from the cutting units in piles and placed in a feeder of the coating line where the pickling is done in the line continuously. The coated sheets are now ready for assorting, packaging and shipping. If the black plate is to be electrolytically tin coated, the coils can be delivered direct from the temper mill to the coating line or to a preparation line where side trimming and building up of the coils can be done before coating.

Figure 2 — The delivery end of the coil conveyer is shown in this photograph.



The strip is now passed through the coating line at speeds up to 1400 fpm depending on the amount of tin to be applied which usually varies from ¼ or less to ¾-lb per base box. The speeds at which the lines run do not accommodate themselves to shearing in the line, as flying shears have not been successfully developed to shear at line speeds. It is therefore necessary to coil the coated plate, and either ship in this state or deliver to the continuous flying shear lines for cutting to customers' requirements.

After shearing the plate is ready for necessary assorting, packaging, and shipping. Unless special processing is required, black plate is ready for shipping after the shearing to size operation.

The galvanizing of cold rolled strip is now going through a change in processing and various methods are being used or contemplated. One process consists of cold rolling to gage, cleaning, annealing in coils, cold rolling on a single-stand two high mill in coils, continuous hot dip coil galvanizing and cutting to sheet size, or shipping in coils if required. The conventional cold rolled process is to shear to size, anneal in sheet form, cold roll, pickle, galvanize, inspect and ship.

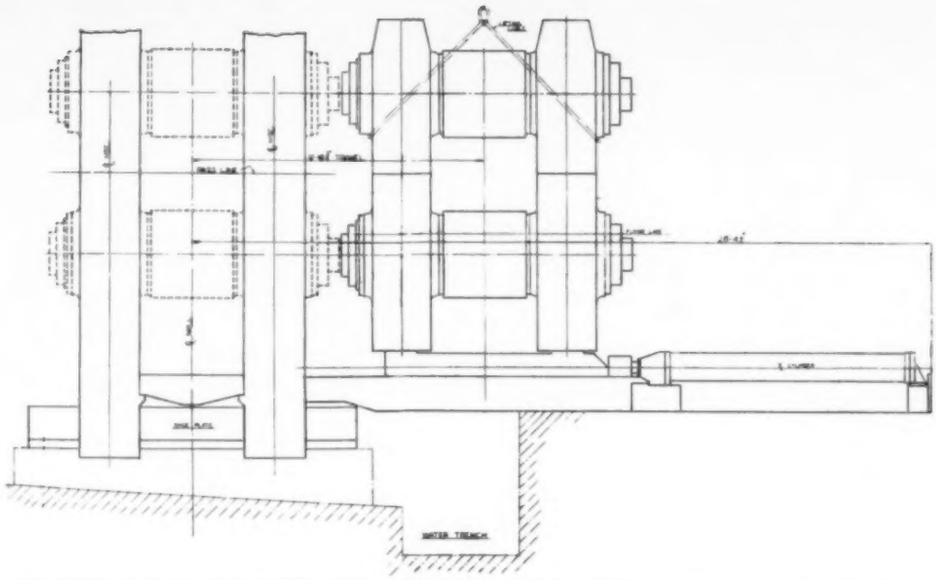


Figure 3 — This schematic elevation which shows the roll changing rig illustrates the ease with which the rolls may be changed.

EVOLUTION OF TIN PLATE PROCESSING

Weirton Steel Company's entrance into the steel business started with the purchase of the Jackson Sheet and Tin Plate Company's plant at Clarksburg, West Virginia in the year 1905, which consisted of a hot train of eight roll stands together with the necessary complement of equipment for the production of tin plate. In 1908 four more stands were added, making a total of twelve. In 1909 a train of ten roll stands together with the necessary equipment were placed in operation at the site of the present Weirton tin mill, and in 1910 ten more mills were added. The purchase of the Pope Tin Plate Company at Steubenville, Ohio added twelve more stands to Weirton's production. By 1916 six more mills were installed at Weirton. At its peak Weirton operated 50 hot tin pack mills, and in addition was cold reducing at this time.

It will be seen from the above that Weirton very quickly became a major producer of tin mill products and that in order to merit the confidence of the customer, it has been necessary to produce the highest quality product. With this thought in mind, Weirton has always been on the alert to provide the latest and most up-to-date equipment.

In 1926 it was decided to increase the capacity of full finished sheets such as are used by the automobile industry. This was at the breaking point between the hot pack sheet process and the continuous hot strip process.

Weirton decided in favor of the hot strip mill installation with the result that the first completely continuous wide hot strip mill was placed in operation in August, 1927. Together with this mill, two four-stand tandem cold strip mills were installed for the purpose of rolling strip to sheet mill gages. The hot strip mill could roll to a finished thickness of No. 16 gage or lighter.

With a larger portion of Weirton's steel being delivered to the tin mill in the form of tin bar for hot pack processing, extensive consideration was given as to how the hot strip band could most economically be cold rolled to tin plate gages.

The first practical method of cold rolling light gages in narrow widths at comparatively high speeds was on a Steckel reversing pull-through mill. Three mills of this type were purchased, the first one in 1929. The mill sizes were as follows:

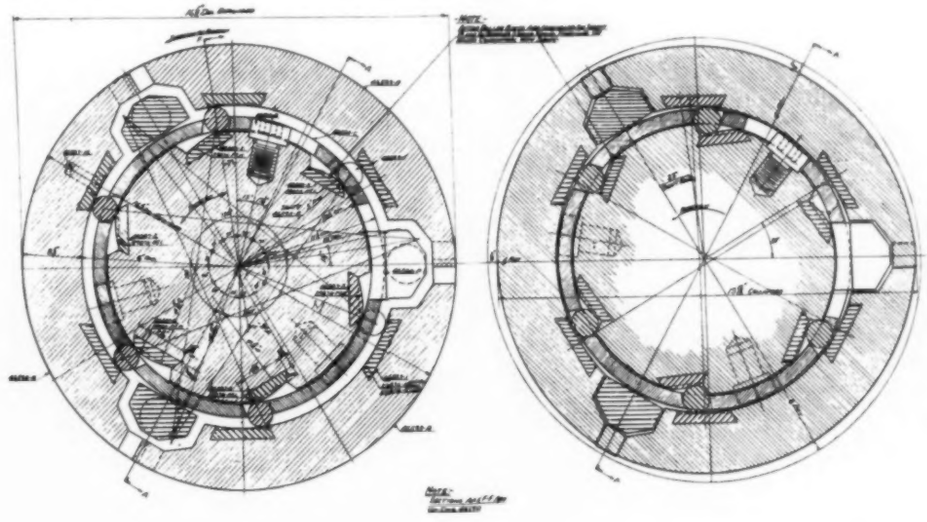


Figure 4 — On the left is shown a cross section of the reel fully expanded showing the relative position of the cage stop on shaft, and on the right is shown a cross section of the reel fully collapsed.

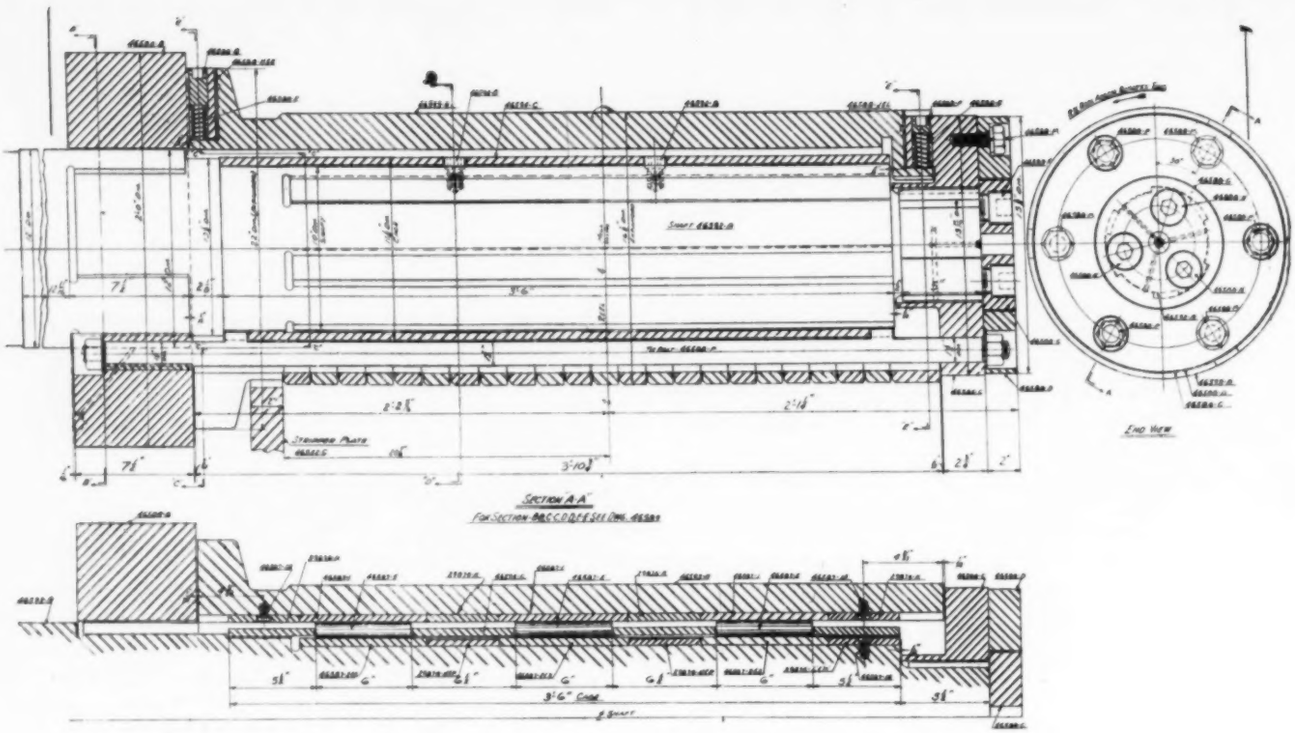
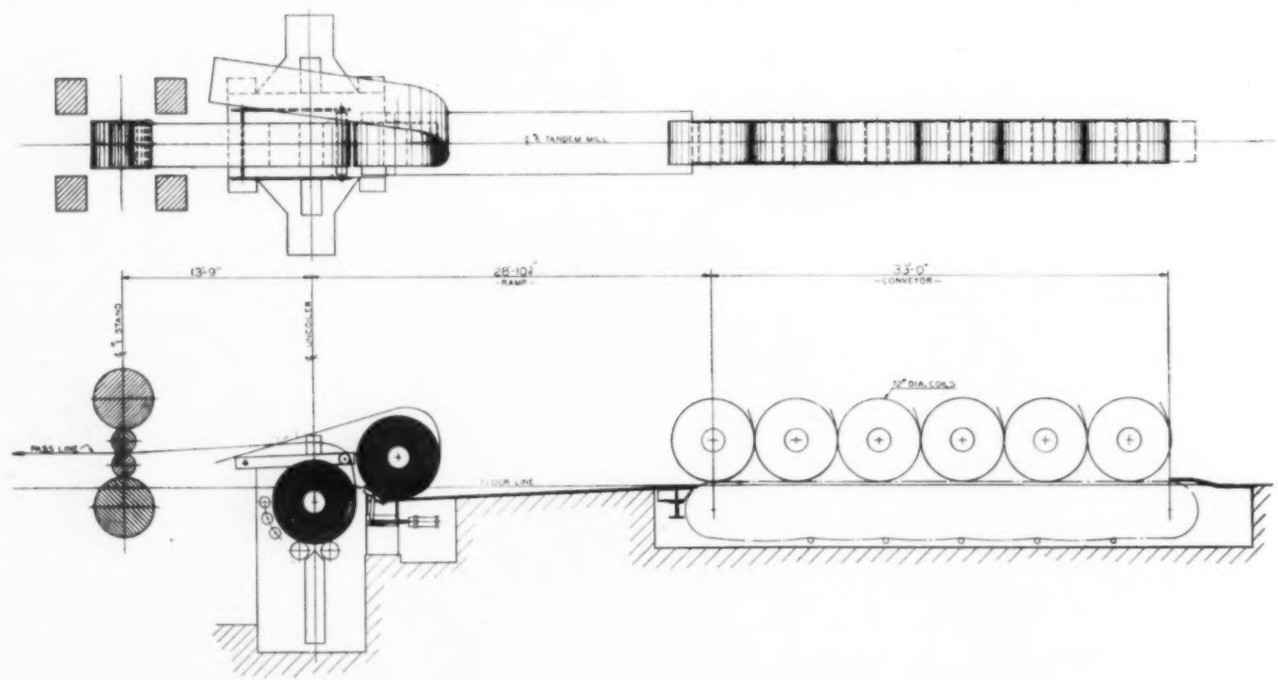


Figure 5 — A longitudinal section showing the arrangement of the reel head is given in this drawing.

Mill No.	Roll sizes	Reel diameter	Reel motor	Max fpm
1	3½ & 24 in. x 24 in. long	22 in.	200 hp, 400/800 rpm	1540
2	5¼ & 27 in. x 30 in. long	26 in.	600 hp, 400/900 rpm	1340
3	5 & 32 in. x 38 in. long	30 in.	2-500 hp, 400/900 rpm	1250

The only change in tin plate manufacture required with this process of cold rolling was to provide lines having a combination of chemical and mechanical cleaning in the tanks, the coils being passed through them to remove the oil and cut to length and piled ready for box annealing. The finished product grew in favor with the

Figure 6 — Shown here is a schematic outline for entry conveyer and ramp for the No. 6 tandem mill.



users, and it was necessary to provide increased capacity. However, it soon became apparent that the reversing mill tonnage was too low, and that a large number of mills would be required to meet increasing demand.

It was then decided to use one train of four-stand tandem cold rolls (known as No. 3 mill) which was installed with original hot mill. To equip these stands with the necessary facilities for light gage rolling, roller bearings were installed to replace the brasses on the work roll necks, and universal type spindles replaced the conventional 4-pod type with loose couplings. The gear drive ratios were changed to provide an increase in speed of the outgoing strip to 470 fpm. The guides in the mills were designed to provide contacts at the bite of the rolls. Improvements in the screwdown were necessary to provide power for moving the rolls with strip in the mill. Having made these changes the mill rolled its first light gage material in 1932. With the exception that a 16½ in. diameter reel and belt wrapper have been added, no other changes have been made to this mill to date, and light gage material is continued to be rolled.

With the demand for cold rolled tin plate increasing, and the success of the No. 3 tandem mill proved, the construction of a complete new No. 4 four-stand tandem mill was started in 1933. Sufficient data had been accumulated by this time to develop, build and operate a mill at higher speeds. It was therefore decided to operate this mill at a maximum finishing speed of 750 fpm.

A complete system of pumps, tanks, filters and collection troughs were incorporated in the construction of this mill for the recirculation of coolant and lubrication to the rolls and strip. It was later discontinued in favor of palm oil application direct to the strip as being rolled.

A unique self-contained unit of back-up roll changing rig was included with each stand of rolls which required no parts, other than the rolls, bearings and cable sling to be handled by the overhead crane. This system proved so satisfactory that it has been included with the construction of No. 5 and 6 tandem cold mills as well as for the new finishing stands of the hot strip mill. The system includes in general a continuous sliding support through the roll stand extending sufficiently beyond the housing on the operator's side to permit lifting of rolls and bearings with the overhead crane. The bottom back-up roll bearings are mounted on a slide which remains in the roll stand with the rolls in place. A hydraulic cylinder of sufficient stroke can withdraw and replace the rolls. In changing rolls the following

Figure 7 — No. 6 tandem mill will deliver strip at speeds up to 5000 fpm.

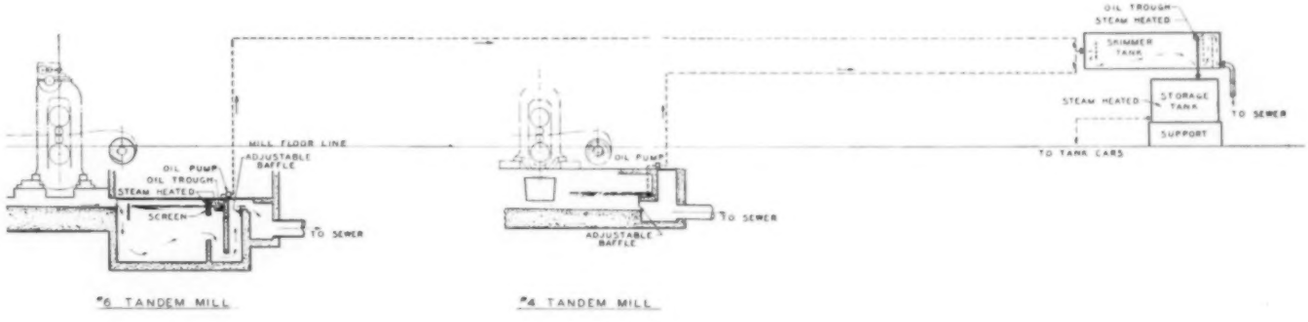
procedure is used—work rolls are removed in the usual manner—the top back-up roll is lowered to bottom back-up roll, both are removed from the roll stand at one time, ready to be taken away with the overhead crane. All operating mechanism is located underneath the floor plates.

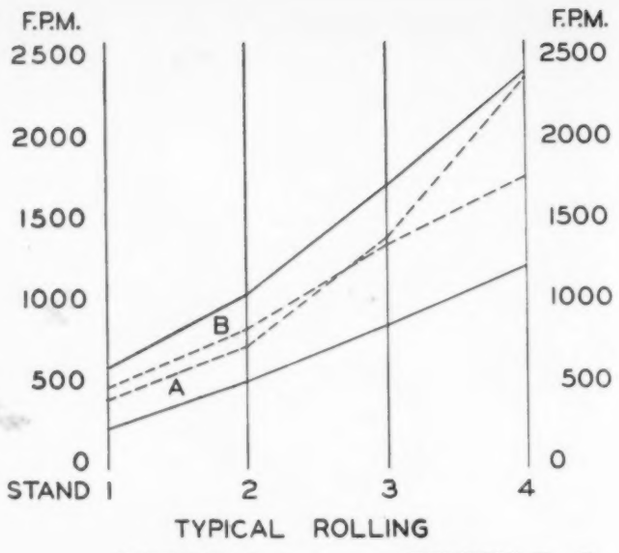
A continuous strip electrolytic cleaning and flying shear unit was installed with the mill for cleaning the strip before delivering to the tin mill. The processing into tin plate from this point was continued the same as for hot pack rolled plate.

This mill, the first to be opened for public observation, attracted considerable attention from the members of the Association of Iron and Steel Engineers in their tour of the Weirton mills in the spring of 1934.

Belt wrapper—In watching the tedious operation of entering the front end of a strip (which was ordinarily buckled badly) into a small slot of the reel head on the original tandem mill, the idea was conceived that a belt, which would encompass the reel head during the starting of the strip and then be retracted, would be a definite time saver and reduce the amount of off-gage material. A unit of this type, the first ever used in the steel industry, was placed in operation on the No. 4

Figure 8 — A schematic outline of the palm oil recovery system for No. 6 and No. 4 tandem mills is given in this drawing.



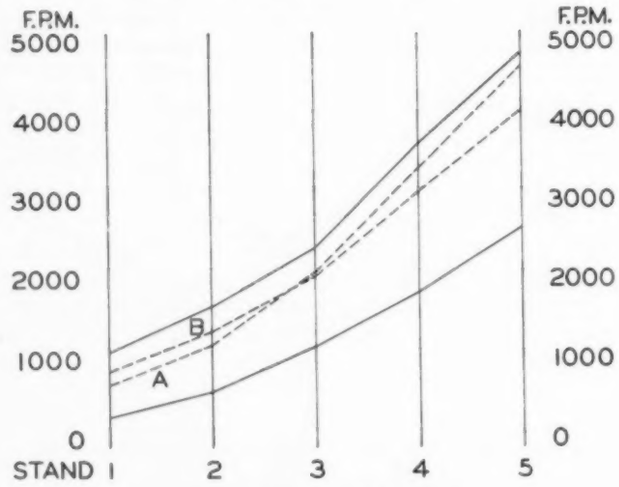


TYPICAL ROLLING

	SCHEDULE A			SCHEDULE B		
STAND NO.	GAUGE .080	% RED.	F.P.M.	GAUGE .080	% RED.	F.P.M.
1	.052	35	420	.055	31.3	500
2	.029	44	750	.032	41.8	855
3	.0155	46.5	1410	.020	37.6	1370
4	.0091	41.3	2400	.0152	24.5	1800

Figure 9 — The speed cone for No. 4 tandem mill with a typical rolling schedule is given in this figure.

Figure 10 — The increase in speeds is well illustrated by this speed cone for No. 6 tandem mill.



TYPICAL ROLLING

	SCHEDULE A			SCHEDULE B		
STAND NO.	GAUGE .090	% RED.	F.P.M.	GAUGE .090	% RED.	F.P.M.
1	.057	36.7	765	.065	27.8	980
2	.034	40.5	1280	.044	32	1450
3	.020	41	2180	.030	32	2130
4	.0125	37.5	3500	.020	33	3200
5	.0091	27	4800	.0152	24	4200

tandem mill. This belt wrapper has proved so satisfactory that practically every sheet and tin plate cold mill is equipped with it, and in addition, it is being used on other processing lines such as cleaning, skin rolling, processing, electrolytic tinning, etc. To further simplify strip entry onto reel, a guide is provided to carry the strip from the mill to the reel.

In 1935, the speed of the mill was increased to 1000 fpm by changing the drive gear ratios and installing additional power for driving the rolls, thereby materially increasing the tonnage of the mill at a very nominal expenditure and only a 4-day shutdown.

No. 5 four-stand cold mill—Due to the phenomenal acceptance of cold reduced tin plate, the producing capacity of existing equipment was rapidly oversold, and in 1935 it was necessary to start the construction of the No. 5 four-stand tandem mill. Until this time only one-slab coils were rolled. With the development of butt welders for use in the pickle lines it was possible to increase the size of the coils for future processing. It was therefore decided to roll two or three slab coils up to a maximum of 50 in. outside diameter and 15,000-lb weight. All of the equipment for processing this size of coil was developed accordingly, including the No. 5 mill, cleaning lines, and annealing furnaces. At that time Weirton's process consisted of cutting to size after annealing and cold rolling in sheet form.

Several new developments were incorporated in the construction of this mill such as an improved type of coil box with rotating side guards to improve edge condition of the coils, and a complete new development of entry guides which was of the completely self-contained type that could be removed from the roll stand with the overhead crane. All of the operating equipment was located substantially below the pass line so that installation of water cooling and oil piping was no problem. The threading of the strip from stand to stand was accomplished readily as no rollers or other equipment for raising or lowering the pass line was necessary.

Reel—Weirton has always cold reduced at the strip steel department and shipped the coils by rail to the tin mills for further processing. It was generally conceded by this time that coils with 20 in. or larger inside diameter had a greater tendency to collapse during shipment than if the inside diameter was, say 16 in. and for this reason, it was decided to construct a head of this size. At that time, even with 20 in. diameter, reel heads difficulties developed in the operation of the heads due to deflection of the segments and rapid deterioration of the parts for collapsing the heads which was caused by the build-up of light gage steel winding. The recognized prime requisites for the new design of reel were as follows:

1. No gripper slot was required as the belt wrapper was capable of starting gages up to 0.035 in. without any difficulty.
2. The collapsing medium must be the equivalent of roller bearing design—namely, hardened inner and outer races with a hardened roller in between.
3. A support for each segment over its entire length to prevent deflection.
4. A shaft size ample to support coil weights without use of outboard bearing.

5. Sufficient collapsing of segments to permit quick removal of the coil.
6. Construction to permit ease of dismantling when required for repairs.
7. Collapsing and expanding medium without use of drive medium as this would weaken the shaft.
8. A balanced head for use with higher speeds.

The result was that a reel head covering above specifications was developed, and this same design and size has been used on the new No. 6 mill at speeds up to a mile a minute with coils weighing up to 32,000 lb. In addition to this, the same design is in use on all coiling operations for light gage material. The total number in operation at Weirton is now 22.

Recognizing the fact that rapid handling of the coils at the delivery end of the mill meant increased tonnage, a coil stripping and discharging arrangement was installed so that coils could be removed from the reel, discharged from the stripping car, rolled over a scale, automatically weighed, and strapped by the operator ready for loading onto cars. Three or four coils could be stored at this point for flexibility of the truck or crane operation.

With the experience gained in the operation of the No. 4 mill at 1000 fpm, it was decided to operate the No. 5 mill at a maximum of 1500 fpm, and no difficulties developed in running at this speed.

No. 4 mill relocation—The No. 4 mill was originally located in the old strip steel department. In 1939 another increase in production of cold rolled tin plate was required and the No. 4 mill was relocated in the 48 in. strip mill department and equipped with sufficient driving power to operate at a maximum speed of 2500 fpm. The operating economies of 15,000-lb coils were quite evident, and it was therefore decided to increase the size of the coil to be processed to a maximum of 16½ in. inside diameter, 66 in. outside diameter, 30,000 lb.

The equipment as developed for the No. 5 mill was satisfactory in all respects for the higher speeds, however a redevelopment of the coil charging was necessary in order to economically and efficiently handle the 30,000-lb coils.

Uncoiler and conveyer—Coils at the charging end of the mill up until this time were stored on an inclined ramp and held in storage position with blocks which required removal by the operators for entry to the coil box. This proved to be a very hazardous method for 15-000-lb coils and prohibitive for larger sizes. Another progressive step in the handling equipment of coils was inaugurated by the installation of a 30-ft long slat-type reversing conveyer onto which a liberal storage of coils could be placed by truck or overhead crane ready for charging in coil box. On strip up to 30 in. wide it is possible for one operator to take hold of the end of the strip and hold it, thereby permitting the coil to roll down a short sloped ramp after being discharged from the end of the conveyer. This permits the ends of the strip to be processed ready for entering into the first stand of rolls as soon as end of preceding coil leaves. This arrangement has proved so satisfactory that mills No. 4, 5 and 6 have been so equipped.

A new improved type of coil box suitable for handling 30,000-lb coils was developed for this installation. Elimi-

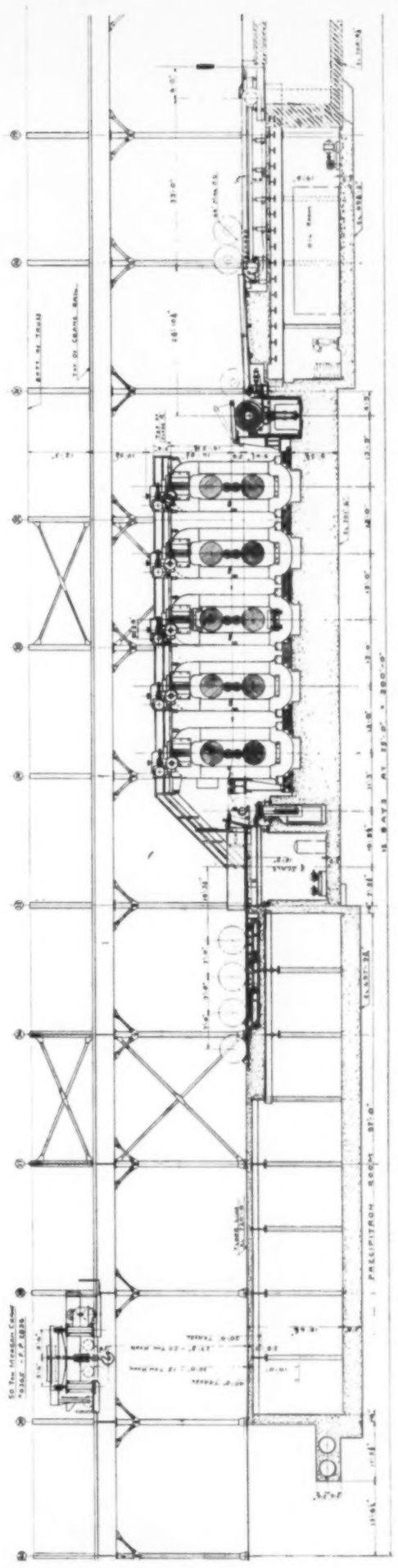


Figure 11 — The general arrangement through the center line of No. 6 tandem mill is shown in this drawing.

nation of the damage of strip edges was required in order to reduce the possibilities of slivers, etc., being carried into the rolls, thereby causing holes in the strip while rolling. A hydraulically operated elevator was incorporated to permit the operator to center the coil with reference to the freely rotating side guards. A gage is installed on the operator's stand for indicating the distance between guards. A group of properly located heavy-type gravity rollers are provided to support the coil. A break roller mounted on a hydraulically operated pair of arms is provided for proper unwinding of the coil. No changes in the roll stands over the original design were necessary due to the increase in speed, except that it was found economical to install oil-type back-up roll bearings on stands No. 2, 3 and 4 in place of the roller bearings.

A liberal arrangement of tunnels, access steps, and space was provided under the floor for the installation of all hydraulic and oil circuating systems, air intakes and electrostatic air cleaning equipment, all electrical control and motor equipment except the main mill motors and motor generator sets.

As the supply of palm oil became scarce it was necessary to provide equipment for its collection from the cooling water flowing over the mill rolls, which was being run into the sewer. Sufficient space was available in the basement to install a pump for raising all of the water to an overhead 16,000-gallon skimmer tank equipped with proper baffling and heater coils so that the water would flow by gravity to the sewer, and then palm oil would flow by gravity to a heated 12,000-gallon storage tank. The palm oil is pumped to a tank car and shipped, as no refining is done at Weirton. A reclamation of about 70 per cent of palm oil is made.

An X-ray gage, for use after the finishing stand, was purchased in 1947. It is expected to improve the accuracy control of finished strip gage, and adapt itself to advantage on high speed mills.

The No. 4 and 5 mill trains and auxiliary equipment were designed, built, and installed by Weirton.

No. 6 tandem cold mill—The demand for increased tin plate capacity required the placing of an order for the No. 6 five-stand tandem cold mill in 1945. The No. 4 and 5 mills are of the four-stand type taking a 0.080 in. hot rolled band, but with the operation of a five-stand mill it is possible to use a 0.090 in. or heavier band, thereby increasing hot strip and pickling unit capacities.

Charging and coiling equipment—After a thorough review of our own existing operations and the installations on other mills, it was agreed by our operating department to duplicate equipment then in use with the exception that a series of disappearing stops were to be provided in the discharge ramp from the coil stripper, so that the coils would not bump one another, thereby causing possible buckling of the inside diameter. An innovation of the hydraulic system was incorporated in that a weighted accumulator was provided for servicing the entry and delivery hydraulic cylinders and other miscellaneous operations using 1000 psi pressure. Another weighted accumulator was provided for roll balance and back-up roll changing rigs operated at 2000 psi.

Roll stands—Each of the roll stands house 21 in. diameter x 42 in. long work rolls mounted in 13.506 in.

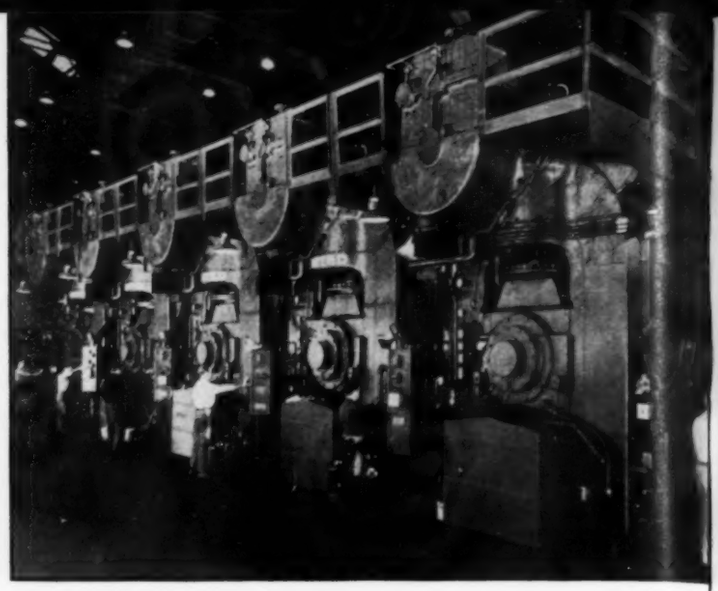
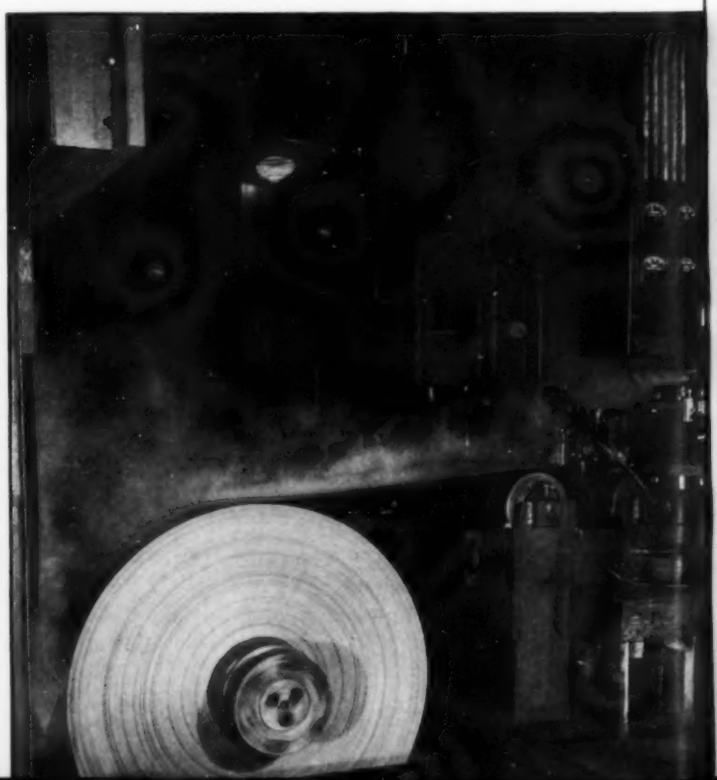


Figure 12 — Skilled operators are required to obtain the maximum production out of a modern tandem mill such as this No. 6 tandem mill at the Weirton Steel Company.

inside diameter x 17.996 in. outside diameter roller bearings having a radial capacity of 81,660 lb at 500 rpm, and back-up rolls having a 53 in. diameter x 41 in. long bodies mounted in tapered neck oil bearings, each having a capacity of 2,850,000 lb. Each housing screw is 18 in. diameter having an indicating wheel mounted in the housing window readily visible to the operator.

The roll changing rigs are identical in design to the ones in use on the other cold mills. A new design tapered end on the work rolls provides for a solid operating mounting of the universal coupling ends which are readily removable for taking off bearings for roll grinding. The top work and back-up roll bearings are equipped with hydraulic balancing cylinders. An indicating

Figure 13 — The reel is directly connected to two 400-hp motors in tandem.



thickness gage is provided after stands No. 1 and 5. Tensiometers are provided after stands No. 1, 2, 3, 4 and 5 for indicating the tensions on the strip.

The roll housings have a cross sectional post area of 29 x 30 in. and a finished weight of 416,000 lb per stand. The screwdowns have a total gear ratio of 800 to 1, and each stand is provided with two 50 hp motors at 725 rpm normal operating speed, and 1900 rpm under light load when roll changes are being made. The motors can operate the screws collectively or individually by disengaging a magnetic clutch as required.

The universal spindles between drives and rolls are mounted in oil circulated sealed bearings which are hydraulically balanced through an air bottle accumulator and readily centered for work roll changing. Figures 9 and 10 show speed cones and several typical rolling schedules for tandem cold mills No. 4 and 6.

Mill drives—With the installation of drives for the original slow speed mills, a medium for reducing speed between the motor and work roll was required. The usual practice is a combination gear reducing and pinion stand unit so that both rolls could be driven from one motor. As the speeds of the mills increased, the roll rpm's came within practical operating speeds of standard motor design, and only a pinion stand was required on the last two or three stands. With the introduction of the high speed mills, the original condition reversed itself in that a step-up gear unit was required, this being caused by the fact that motors of large horsepower could not be operated at the required high speed due to physical characteristics. It was also necessary to provide two motors per roll stand in order to keep the motor as small as possible physically, providing a minimum of WR^2. This condition led to the idea that a separate motor could not be used for driving each of the work rolls on stands No. 4 and 5. Accordingly, the gear speed up units were designed individually for each motor, but mounted in a common housing unit. While the driving of rolls individually was not new to the steel industry, it was new as far as cold mills were concerned, and in order to provide a flexible arrangement, provision for a tie-in gear was made so that the drive could be operated with the rolls driven either independently or collectively. The mill was placed in operation with each roll being driven independently, and after about one month's running it was decided that the shape and surface of the strip were being adversely affected. The tie-in gears were installed in No. 4 and 5 mills and conditions were improved. The units are now operating in that manner.

The drive arrangement of the entire mill train is as follows:

1—1750 hp, 70 to 210 rpm motor connects direct to pinion stand for No. 1 roll stand.

1—3500 hp, 125 to 312 rpm motor connects direct to pinion stand for No. 2 roll stand.

2—1750 hp, 225 to 450 rpm motors in tandem connect direct to pinion stand for No. 3 roll stand.

1—1750 hp, 225 to 450 rpm motor connects through a 1.5 to 1 gear increaser to each work roll for No. 4 stand.

1—2250 hp, 250 to 450 rpm motor connects through a 2 to 1 gear increaser to each work roll for No. 5 stand.

The 16½ in. diameter reel is directly connected to

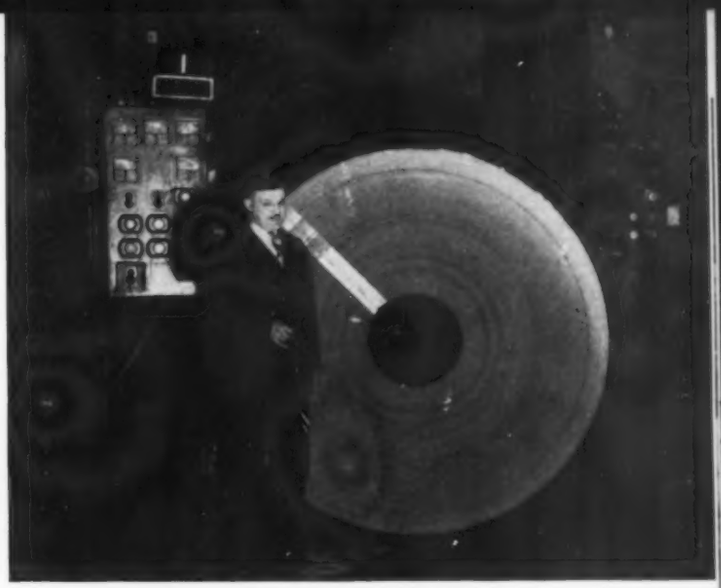


Figure 14 — The size of the coils is illustrated by the height of the man standing alongside of the coil.

two 400 hp, 300 to 1100 rpm motors in tandem. A total of 17,550 hp is provided for the five roll stands and the reel. Two motor generator sets, each unit consisting of one 9900 hp, 360 rpm, a-c motor and two 3500 kw, 360 rpm, d-c generators are connected to a common bus bar for flexibility of operation. The motor generator sets are located on the mill floor level, all controls being located in the basement. As the electrical equipment will be described in the next article by Mr. A. F. Kenyon, we will not go into further detail of this item of operating facilities other than to say that, if it were not for the development of motors and controls in conjunction with all other phases of the equipment and operation, the high speed mill would not be a successful operation today.

Lubrication—In the operation of a high speed mill with the great variation in speeds and pressures, different viscosities of oil are preferable to provide the greatest factor of safety in operation, and on this basis two complete separate units were provided for each of the drives and back-up roll bearings as follows:

System No. 1 furnishes the necessary 1600 SSU oil at the rate of 90 gpm to the back-up roll bearings for No. 1 and 2 stands. Oil is stored in two 4000-gallon receiving

Figure 15 — Large lift trucks are required to handle the coil sizes rolled on No. 6 mill. The weight of the coil shown is 22,100 lb.

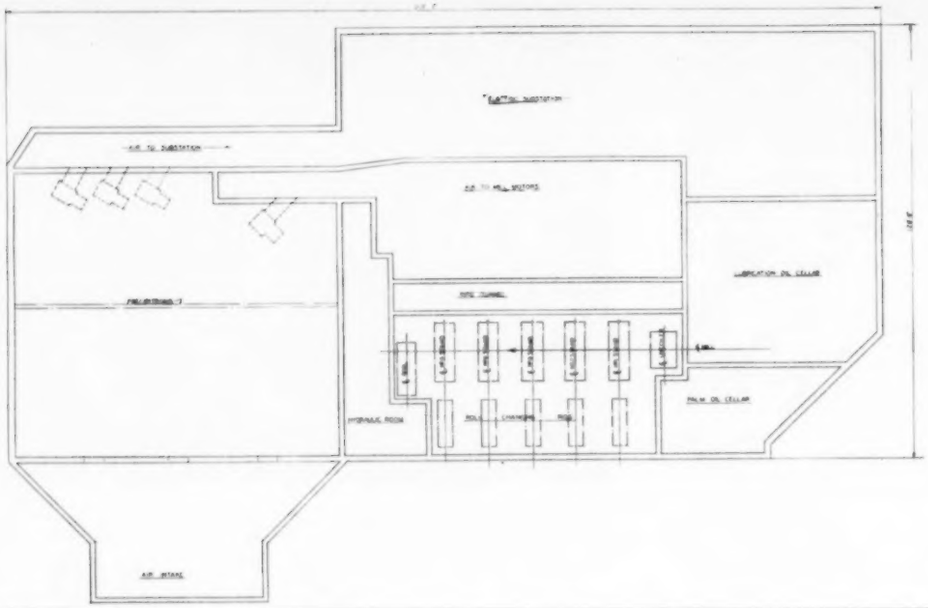


Figure 16 — The basement layout for No. 6 tandem mill is shown here.

tanks equipped with floating suctions, thermometer, steam coils, cleanouts, etc. A solid cover with manhole cover entrance keeps foreign matter from getting into the tank. The necessary spare equipment and control features are installed to provide automatic changeover from one pump to another, in case of system failure, and to signal operators that attention is needed. This feature is included in all systems. Water coolers are included in all systems for automatically maintaining oil at predetermined temperatures. Pressure filters are installed in the systems for removing the major part of foreign matter which may collect in the system. Portable centrifuges are available for further refining if necessary.

System No. 2 supplies 800 SSU lubricant at the rate of 340 gpm to the back-up roll bearings of No. 3, 4 and 5 stands. Two 16,000-gallon receiving tanks and a 400-gallon pressure tank with the necessary complement of operating equipment such as oil filters, coolers for oil temperature, regulators, pressure gages, switches, etc., are installed to provide an operating system as foolproof as possible.

System No. 3 provides lubrication for the pinion stand driving No. 3 roll stand and the gear drives for No. 4 and 5 stands. Pumps having a capacity of 130 gpm of 1300 SSU extreme pressure oil at 100 F are provided for circulation.

System No. 4 lubricates No. 1 and 2 mill stand pinions and all of the screwdown equipment. Pumping capacity is 130 gpm of 2300 SSU extreme pressure oil at 100 F. The oil receiving tank has a capacity of 600 gallons and the pressure control tank a capacity of 100 gallons.

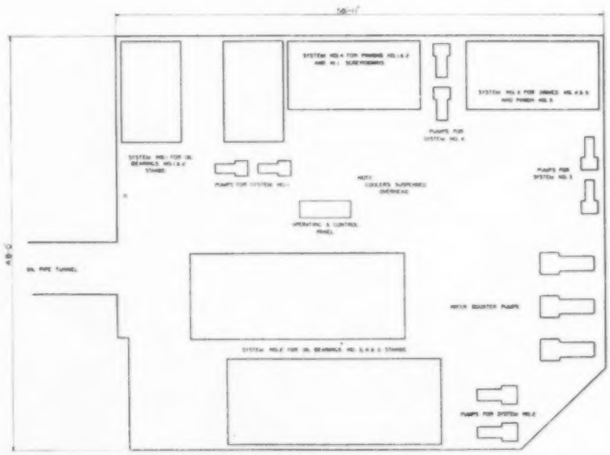
System No. 5 supplies palm oil in controllable quantities to the desired number of points, and in addition to this, palm oil is applied through the tensiometer to the bottom of the strip. This system consists of one 4-unit (3 water to one palm oil) proportioning pump having a maximum capacity of 75 gphr and a minimum capacity of 5:8 gphr per unit, one spring loaded check valve, six 7-feed distributors giving a total of 42 feeds, each feed delivering one gallon per hour, a pressure gage with a range of from 0 to 80 psi, six class "D" regulating valves, one 100-gallon mixing tank equipped for 170 F temperature at 300 gphr, including heater coil and float gage, and one 75-gallon hot water tank for preheating water to 160 F. The palm oil is piped to the system through heated lines.

System No. 6—One motor operated centralized pressure grease lubricating system automatically supplies a predetermined amount of grease to the work roll bearings, and another duplicate unit provides grease supply to the uncoiler, miscellaneous mill parts, reel and stripper.

Hydraulic water at a pressure of 180 psi, as well as mill water at a pressure of 40 psi is available at the operator's discretion on the entry side of all roll stands and on the delivery side of the first four stands at the top and bottom work rolls. It is estimated that a total of 300 gpm of water is used for roll and strip cooling, depending on conditions.

A heavy system of floor structure capable of supporting the 30,000-lb coil truck handling unit is provided. A 60 in. grinder for servicing the work and back-up rolls is located adjacent to the mill. Precipitron cleaned air at the rate of 378,000 cfm is supplied to the electrical equipment.

Figure 17 — Schematic plan of oil cellar.



Operating problems for the rolling of light gage strip begin in the steel works department and special attention is given to provide proper analysis of steel, surface conditioning and the elimination of conditions not conducive to quality tin plate. In rolling the slab to strip gage, controlled quantities of high pressure water for surface are provided and special attention is given to provide constant strip gage, as in the welding together of coil ends the variation must be kept to a minimum to enable the cold mill operators to produce the maximum number of full size coils. Good trimming of the coil in the pickling operation provides another safeguard in the rolling operation, mainly the elimination of cracked edges. Handling the coils to the mill requires care to eliminate damaged edges. Providing a rotation of side guard while uncoiling for entrance to the first stand should prevent slivers from getting on the steel from the edges. Guide boards provide a constant source of inspection for marks on the steel. Constant watching of roll tension between stands is necessary to reduce breakage. A consistent supply of palm oil is required to provide accurate finished gage. Cooling water must be watched in order to maintain shape of mill. In order to provide good strip surface and maximum roll life the rolls are changed as follows unless wrecks dictate otherwise:

Stand No	Work rolls	Back-up rolls
1	56 hours	21/28 days
2	48 hours	14 days
3	24/32 hours	14 days
4	16/24 hours	7 days
5	8/10 hours	7 days

From 0.008 to 0.012 in. is removed per dressing from work rolls and $\frac{1}{32}$ in. from diameter is ground from the back-up rolls, except on every third dressing $\frac{1}{16}$ in. is removed. In the coiling of the steel it is important to provide a tension on the strip which through experience causes the least amount of coil collapsing and to remove any excess water which might be trapped between the layers of steel also causing collapsing. A straight-sided

TABLE I

Rolling Mills

Train No.	Stand No.	Roll, work	Roll, back-up	Housing post	Roll stand centers	Gear ratio	Fpm Min	Fpm Max	Motor Hp	Motor Rpm	Motor-generator set	Tons
3	1	16 in. diam	38½ in. diam	365 sq in.		21.1	80	160	500	400/800	1500 kw	
(1932)	2	42 in. long	42 in. long		25 ft-0 in.	14.09	119	238	500	400/800	2100 hp	
	3				25 ft-0 in.	9.9	169	338	500	400/800		
	4				25 ft-0 in.	7.14	235	470	500	400/800		
	Reel	16¼ in.			9 ft-8 in.	8.1			75	225/300		
	Total				84 ft-8 in.				2075			
4	1	19 in. diam	42 in. diam	470 sq in.		17.35	129	258	600	450/300	1500 kw	
(1933)	2	36 in. long	35 in. long		16 ft-0 in.	10.4	144	432	600	300/300	2250 hp	
	3				15 ft-0 in.	7.13	209	627	600	300/300		
	4				15 ft-0 in.	5.96	253	760	600	300/300		
	Reel	25 in.			8 ft-6 in.	8.84			150	600/1400		
	Total				54 ft-6 in.				2550			
4	1	19 in. diam	42 in. diam	470 sq in.		17.35	129	258	350	450/300	2250 kw	
(1935)	2	36 in. long	35 in. long		16 ft-0 in.	10.4	144	432	600	300/300	3350 hp	
	3				15 ft-0 in.	7.13	209	627	600	300/300		
	4				15 ft-0 in.	4.42	338	1014	1200	300/300		
	Reel	25 in.			8 ft-6 in.	8.84			150	600/1400		
	Total				54 ft-6 in.				2300			
4	1	19 in. diam	48¾ in. diam	470 sq in.		7.13	244	610	700	350/875	6000 kw	1
(1939)	2	36 in. long	35 in. long		12 ft-7 in.	2.82	528	1056	1750	300/600	8400 hp	
	3				11 ft-9 in.	0	868	1735	1750	175/350		
	4				11 ft-9 in.	0	1222	2445	2500	250/500		
	Reel	16½ in.			10 ft-6 in.	0			300	125/600		
	Total				46 ft-7 in.				7000			
5	1	19 in. diam	45 in. diam	470 sq in.		15.95	186	373	400	600/1200	3500 kw	1
(1935)	2	36 in. long	35 in. long		12 ft-7 in.	5.72	348	696	1000	400/800	5100 hp	
	3				11 ft-9 in.	3.966	502	1004	1000	400/800		
	4				11 ft-9 in.	2.318	647	1500	1500	300/700		
	Reel	16½ in.			9 ft-0 in.	3.875			200	300/1200		
	Total				45 ft-1 in.				4100			
6	1	21 in. diam	53 in. diam	870 sq in.		0	385	1155	1750	70/210	2 Sets	
(1947)	2	42 in. long	41 in. long		13 ft-0 in.	0	687	1718	3500	125/312	7000 kw	
	3				13 ft-0 in.	0	1237	2474	3500	175/400	9300 hp	
	4				13 ft-0 in.	1.5 Increase	1919	3838	3500	225/450		
	5				13 ft-0 in.	2.0 Increase	2750	4350	4500	250/450		
	Reel	16½ in.			11 ft-3 in.	0			800	300/1100		
	Total				63 ft-3 in.				17,550			

coil is essential for the elimination of damaged edges in shipment.

A tabulation of pertinent data covering the evaluation of cold rolling mills as covered by this paper is given in Table I for compact observation.

Quality control—The following gives the close follow-up made by the quality control department on an order for tin plate, which is the ultimate product of the coils cold rolled on the No. 6 tandem mill.

An order is received by the sales department which sends it to the quality control department for specification and processing. If the order is for a new part, this department also develops from blueprints and sample parts what is necessary for successful fabrication. After the order is made up and the steel is ordered, observation is made of the open hearth practice and a check is made to see that the proper steel analysis is applied. After the rolling of the ingots in the blooming mill, the slabs are inspected and marked for proper scarfing so that all major steel defects may be eliminated. At the hot strip mill correct application of heat is again checked and finishing and coiling temperatures established according to the type of order being rolled. At the entry end of the pickler, this department checks for lamination and any other defects that might cause poor welds. Routine analysis of the pickler bath for acid percentage and temperature are also made. At the cold reduction mills a close check is made on the finished gage by use of templets and regular weight checks. The steel is then shipped to the tin mill where the chemical analysis is again checked on all special steels. At the cleaners the alkalinity of the cleaning solution together with supervision of additions and temperatures are regularly checked to insure proper cleaning. Coils leaving the cleaner go to the anneal where an annealing cycle is set up depending upon the type of steel and final physical properties desired. After annealing the coils go to the temper mills where a close inspection is maintained to see that the correct temper ranges are met.

After temper rolling the plate goes either into hot dip or electrolytic plate. That going into hot dip is sheared into cut lengths where it is thoroughly checked for temper and other physical properties. The sheared sheets are then pickled and the pickling solution is checked for acid concentration and temperature. The plate is then coated and this coating is spot checked for amount and distribution of tin. The final product is inspected for surface, size, shape, and weight standards as set up by the quality control department. The coils that are to be electroplated are taken direct from the skin mill to the electrolytic line for coating. On the electrolytic line control tests are run on the cleaner, pickler, electrolyte, and chemical treatment to see that they are maintained within proper established limits. The plate is checked for oil film weight and the coating for amount and distribution of tin. Packaging specifications have been developed by this department for both the hot dip and electrolytic plate.

This close follow-up is to insure the customer of receiving the type and quality of plate required. The research group in the quality control department is continually making tests of various types to improve the quality of our tin plate production.

DISCUSSION

PRESENTED BY

G. A. KAUFMAN, Chief Electrical Engineer, Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania

C. J. KLEIN, Chief Engineer, Weirton Steel Company, Weirton, West Virginia

G. A. Kaufman: I would like to ask Mr. Klein one question. Can he explain how the chafing and the scratching are caused by twin drives on stands 4 and 5? We have found that you can run a mill with twin drives and we find no such condition.

C. J. Klein: As stated in the paper, we believe our mill was the first one of its type to be contracted for with the individual motors on each work roll of the last two stands. Being just a little foresighted, we felt that we were going into something new and by the addition of one extra gear in each drive, with no additional size of the drive or cost in the development of the drive, we could provide a unit which could be operated either as an individual drive for each roll, or for a collective drive.

We ran this mill for several months with the rolls driven independently. As everyone knows, when a mill is put into operation there are quite a few problems that develop, which in the operator's mind can be caused by any number of conditions. Naturally we were having some trouble in the marking and chafing of our steel as well as shape, and that was a matter I believe of the operators becoming acquainted with the operation of a new and much heavier mill than we had been accustomed to.

They naturally felt that one of the things that was giving them trouble was the fact that the rolls were driven individually. On that assumption, they decided to put the idler gears in, feeling that they would overcome some of their problems, because that was the conventional way of doing the thing; in other words, all the mills that were ever operated were driven that way. So as a result the gears were put in, the drives have run just as a regular mill, and one of the things that they thought was giving them trouble was out of the picture in that the rolls were tied together.

From an engineering standpoint, I believe the rolls can be driven either way, from the operator's standpoint they feel they have solved one of their problems.

G. A. Kaufman: We have found by having these rolls separately driven we can actually tell whether we have an equal amount of palm oil on top and bottom by differential meter readings. Furthermore, there is no need to grind your rolls to accurate match. Why waste steel on a good roll? Put it in; you cannot detect the difference and the shape is still good and the scratches are not there. Why not take the idling gears out and have the advantage of twin drives?

C. J. Klein: The only thing I can say in answer to Mr. Kaufman's remarks is that I believe the Jones and Laughlin and Weirton operators should get together and further discuss this condition.

Electrical Drive Equipment for New High Speed Tandem Mill

. . . . the development of the modern, high speed strip mill would have been impossible without the development of dependable controls by the electrical manufacturer . . . .

By A. F. KENYON, Steel Mill Engineer
Westinghouse Electric Corporation
East Pittsburgh, Pennsylvania

▲ THE new 42 in. five-stand tandem cold reduction tin plate mill marks a major development in the cold reduction process of tin plate rolling, and typifies the trend to higher and still higher rolling speeds, greater power of driving motors, and refinement of the control and regulating equipment. This mill is capable of operating at delivery speeds up to 5000 fpm, one-third faster than any mill previously installed. The 17,550 hp rated capacity of the mill and reel motors is the largest total power on any cold reduction mill, and the 4500 hp drive for stand No. 5 is the largest applied to any single cold reduction mill stand. The mill is the first high speed tin plate mill to make use of twin-motors for the separate drive of the upper and lower working rolls of stands No. 4 and No. 5, and the first to use a regulating type tensiometer to control the winding reel.

The mill was first operated in May, 1947. Naturally, some minor changes have had to be made, and operating procedures developed, however, after a year's operating experience, the expected mill output of 40,000-45,000 net tons per month of average tin plate strip has become routine.

DEVELOPMENT OF TANDEM TIN PLATE MILLS

Before proceeding to a description of the new Weirton mill, a brief review of the developments in tandem tin plate mills over the past twenty years may be of interest. The first such mill, installed in 1928, and consisting of four 32 in. stands, was laid out for only 340 fpm maximum rolling speed, and the mill and reel motors totalled only 1020 hp. The first point on Figure 1 shows this humble beginning, and the other points show the progressively higher speed for which each succeeding mill was designed. By 1936 the average maximum speed had increased to about 1500 fpm, with eight or nine mills designed for about this speed. Since 1938 the increase in mill speeds has been phenomenal, with 2500 fpm for the Weirton No. 4 mill put into service in 1940, 3800 fpm for the Irvin No. 2 mill in 1942, and 5000 fpm for the Weirton No. 6 mill in 1947. There has since been put into operation a mill at Aliquippa, which is capable of operation up to 6000 fpm maximum, however, with slightly smaller power than on the 5000 fpm Weirton mill.

The unit energy consumption (horsepower-hours per ton rolled) is practically the same whether rolling at 1500 fpm or 4500 fpm. Thus, the installed motor capacity has increased practically in proportion to the maximum mill speed, and the motor capacity per 1000 fpm maximum mill speed has not changed significantly, averaging about 3500 hp, as shown by Figure 2. On this chart, the data for the few mills narrower or wider than the standard 42 in. tin plate mill have been corrected to that base.

DETERMINATION OF MOTOR CAPACITY

We need not take time to go into detail power calculations, as the methods of calculation to estimate the loads on the mill and reel motors for any particular rolling schedule have become well standardized, and papers presented before the Association of Iron and Steel Engineers have explained in detail the procedure in making the power calculations, and have included energy consumption curves plotted from test data from many different mills.

The new Weirton mill is primarily for the production of light gage strip for tin plate, ranging from 0.006 to 0.015 in. thick and from 20 to 39 in. wide. The mill also must be able to produce some sheet gage material up to 0.025 in. thick. In setting up rolling schedules, it was arbitrarily specified that the mill should be capable of rolling all finished gages from 0.006 to 0.025 in. thick from the same 0.095 in. thick hot strip, although it was recognized that more advantageous cold mill operation could be obtained by varying the gage of the entering hot strip to suit the gage of the delivered cold strip. The motor ratings were selected to provide capacity to roll all tin plate strip schedules up to 0.0124 in. thick and 36 in. wide at normal speed of 4000 fpm. Heavier sheet gage or wider tin plate strip could be rolled at lower speeds, and reserve speed should be available so that under favorable conditions narrower light gage tin plate strip could be rolled at maximum speeds approaching 5000 fpm.

Figure 3 summarizes the speed and power relations for the range of finished strip thickness from 0.006 to 0.025 in., assuming all finished gages rolled from the

Presented before AISE Pittsburgh District Section Meeting, May 10, 1948

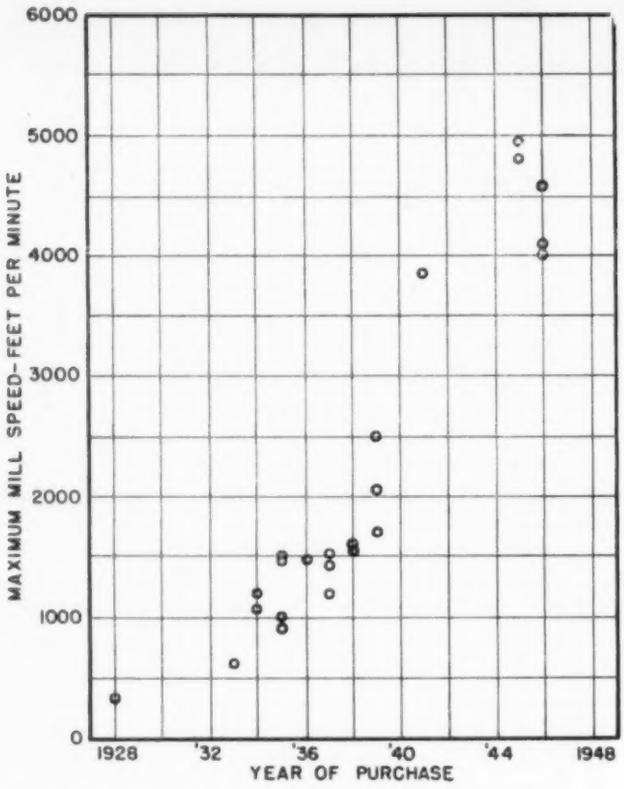
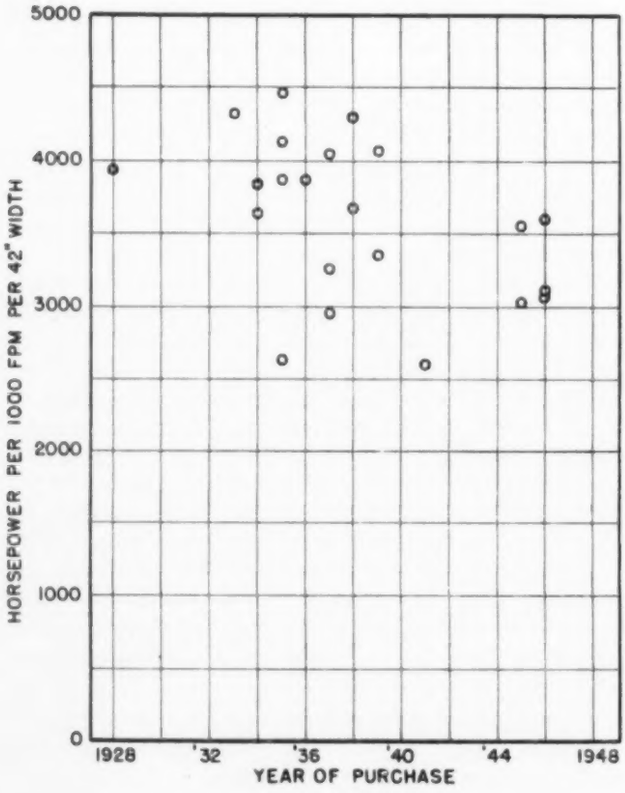


Figure 1 — Speeds in tandem cold reduction tin plate mills have increased from 340 fpm in 1928 to 5000 fpm in 1945.

Figure 2 — The unit horsepower on tandem cold reduction tin plate mills has changed little with time.



same 0.095 in. thick hot strip, and all 36 in. wide. The bottom curve shows the horsepower-hours per net ton, as determined from tests, required to reduce from 0.095 in. thick entering hot strip. Then assuming 4000 fpm rolling speed for all finished gages, the rolling rate in tons per hour will be proportional to the finished gage and the total horsepower will be the product of the rolling rate and the unit energy consumption, as shown by the solid curve, varying from about 13,500 hp when rolling 0.006 in. thick to 20,500 hp when rolling 0.025 in. thick strip. Or assuming that 17,500 hp available motor capacity is utilized on all schedules, the rolling rates and rolling speeds will be as shown by the dashed lines, it being possible, from the power standpoint, to roll 0.006 in. finished strip at about 5200 fpm, and 0.025 in.

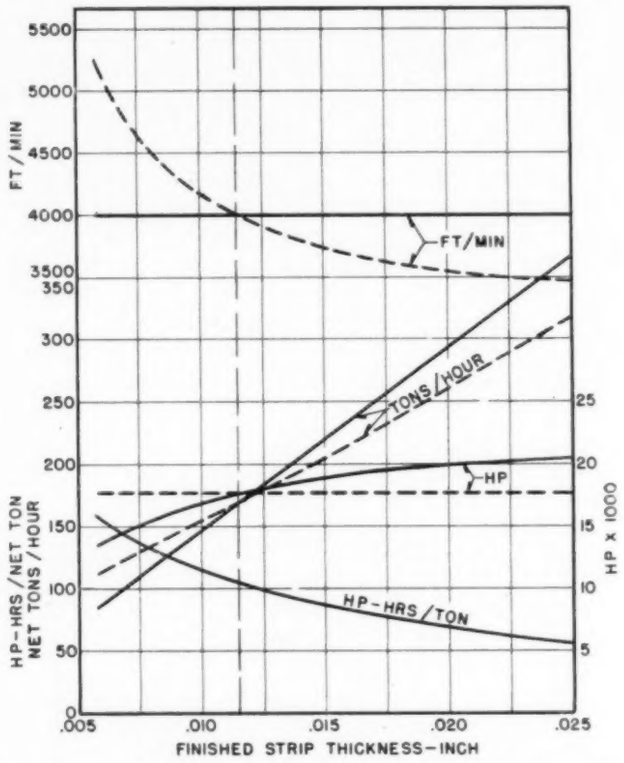


Figure 3 — A summary of the speed and power required for rolling various finished strip thicknesses from 0.095 in. hot strip, 36 in. wide.

at 3450 fpm. As mentioned, this analysis is on the basis of 36 in. wide strip, and wider or narrower strip will impose correspondingly larger or smaller total loads, or to utilize the same available power would need to be rolled at correspondingly slower or faster speed.

From such analysis, it was determined that the mill should have about 17,550 hp total drive capacity, and from detailed calculations and comparison with the drives on other mills, a 1750-hp motor was selected for stand No. 1, 3500-hp for each of stands No. 2, No. 3, and No. 4, 4500-hp for stand No. 5, and 800 hp for the reel. The mill and reel motors, as well as the main and booster generators, are rated 40 C rise continuous, and have full Class B armature and field insulation, and hence can carry the overloads imposed by occasional heavy schedules without exceeding safe machine insulation temperature.

STAND SPEEDS

Figure 4 is a speed diagram, or "speed cone" as it is commonly called, showing the speeds selected for each of the five mill stands, to meet the range of requirements, from thin finished strip with heavy drafts and large total elongation, to sheet gage strip with relatively light drafts and small elongation. The shaded areas indicate the speed ranges due to variations of working roll diameter, and speeds in these areas may or may not be available depending on the rolls being used. The required speeds for several typical rolling schedules are shown by the dashed lines.

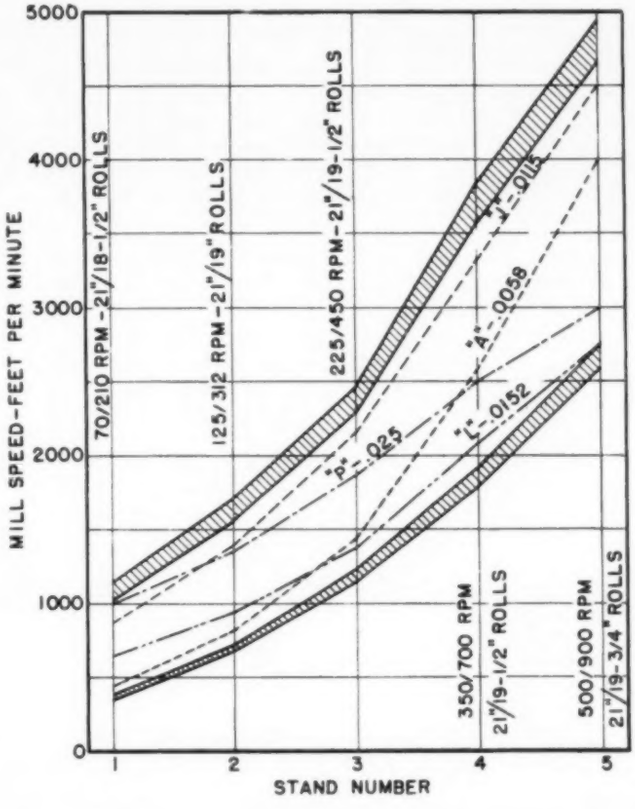


Figure 4 — The speed diagram for the 5-stand tandem cold reduction tin plate mill is given in these graphs.

ELECTRICAL DRIVE EQUIPMENT

The mill motors and power supply motor-generator sets are shown in Figure 5. The motors and method of drive to the mill are as follows:

Stand No. 1—1750-hp, 750-volt, 70/210 rpm, single armature motor, direct coupled to the mill pinion stand.

Stand No. 2—3500-hp, 750-volt, 125/312.5 rpm, single armature motor, direct coupled to the mill pinion stand.

Stand No. 3—3500-hp, 750-volt, 225/450 rpm, double armature motor, direct coupled to the mill pinion stand.

Figure 5 — Two 7000 kw main motor-generator sets supply power to the mill and reel motors.

Stand No. 4—Two 1750-hp, 750-volt, 225/450 rpm, single armature motors, comprising a 3500-hp twin-motor for separate drive of the upper and lower mill working rolls through 1.55:1 ratio step-up gears, giving a roll speed of 350/700 rpm.

Stand No. 5—Two 2250-hp, 750-volt, 250/450 rpm, single armature motors, comprising a 4500-hp twin-motor for separate

Figure 6 — A 378,000 cfm electrostatic air cleaner is used for ventilation of the tandem mill motor and the motor-generator sets.

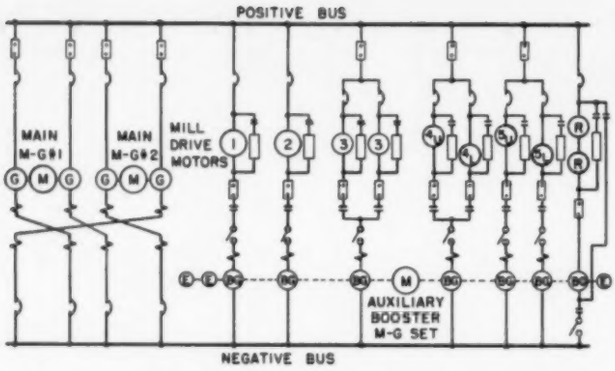


Figure 7 — Diagram of main connections for tandem cold reduction tin plate mill. A common bus system is used for power supply and series booster generators for IR drop compensation.

drive of the upper and lower mill working rolls through 2.0:1 ratio step-up gears, giving a roll speed of 500/900 rpm.

Reel —800-hp, 2 x 375-volt, 300/1100 rpm, double armature motor, direct coupled to the reel shaft.

The stand No. 1 and No. 2 motors were made with narrowed frame feet and bedplates, and the stand No. 4 and No. 5 twin-motors were made opposite hand to fit the motors between existing building columns. The electrical parts and armatures with shafts of the stand No. 4 twin-motor are interchangeable with the stand No. 3 double armature motor.

Power for the mill and reel motors is supplied by two 7000-kw motor-generator sets, each set consisting of two 3500 kw, 720-volt generators, and 9900-hp, unity power factor, 6600-volt, 3 phase, 60-cycle, 360 rpm, synchronous motor. Oil pressure lift pumps are provided for the two large motor bearings to float the shaft before starting, thus reducing the required starting torque, and enabling starting from a lower voltage tape on the reactor. The two 9900-hp synchronous motors are excited from a 125 kw exciter, and the exciter is controlled by a rotating regulator to vary the synchronous motor excitation and maintain unity power factor over the operating load range.

The mill and reel motors and the two main motor-generator sets are installed in the hot coil storage building, between the hot strip mill building and the cold strip mill building, and without the protection of a motor room. The machines are equipped with front and rear enclosing covers, and arranged for updraft ventilation. Ventilating air is taken from outside the cold strip mill building through tunnels under the mill floor, and cleaned by an electrostatic air cleaner. Figure 6, of 378,000 cfm total capacity. Three 42,000-cfm fans supply air for the mill and reel motors, and three 60,000-cfm fans supply air for the main motor-generator sets and the underground control room.

Figure 8 — An eleven unit auxiliary booster and exciter motor-generator set is installed in the underground control room.

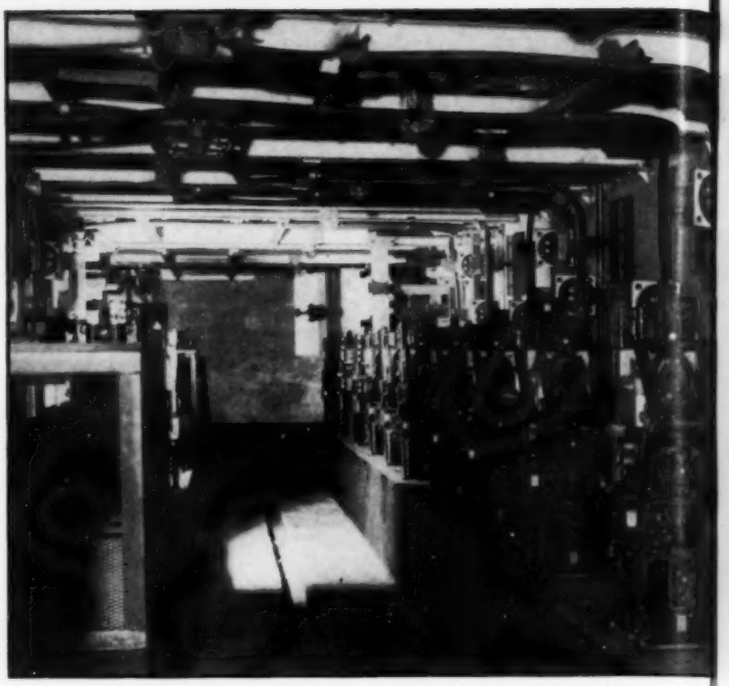


Figure 9 — The air circuit breakers are mounted on a pedestal inside the foundations under the motor-generator sets.

MAIN CIRCUIT CONNECTIONS

Figure 7 is a diagram showing the main armature circuit connections for the mill and reel motors and the main and booster generators. The four 3500-kw main generators have differential and crossed cumulative series fields, and are connected in parallel to the common bus from which the mill and reel motors are supplied. In the armature circuit of each mill motor, there is provided a series booster generator, which is adjusted to develop voltage proportional to load and approximately equal to the IR drop in the motor circuit. This compensation for IR drop together with armature demagnetization compensation assures practically the same ratios of speeds of the different stands at low threading speeds, as at normal rolling speeds, affording stable operation during threading, and assisting to maintain gage during changing speed conditions. The subject of IR and demagnetization compensation was discussed in detail in papers read before the Association of Iron and Steel Engineers by Mr. G. E. Stoltz, and published in the 1941 and 1942 Proceedings.

Before determining to use the common bus system of power supply, with IR compensation obtained by series

booster generators, consideration was given to a separate generator system in which each mill and reel motor is supplied from an individual generator, with IR compensation obtained by bias control of the generator voltage. The separate generator system has recognized advantages of wider speed range and hence greater flexibility in making up rolling schedules, smaller short circuit currents under fault conditions, elimination of the large current low voltage booster generators, simplification of main connections, etc. However, it also requires a much more complex and critically adjusted regulating system to maintain the proper steady-state and transient speed relations over the range from threading to running speed, and during rapid acceleration and deceleration. At the time the Weirton mill was under consideration (1945) no installation had been made using the separate generator system, while several mills, beginning with the 2500-fpm Weirton No. 4 mill, were in successful operation using the common bus system. The desire to keep the regulating equipment as simple as possible, therefore, led to the installation of the common bus system.

The eleven-unit auxiliary booster and exciter motor-generator set, shown in Figure 8, is installed in the underground control room. The set consists of the six IR compensation booster generators, 300-kw, 350-volt, reel booster generator, 125-kw exciter for the two 9900-hp synchronous motors, 50-kw exciter for the four 3500-kw generators, 75-kw constant potential exciter, and 1500-hp, 0.9 power factor, 6600-volt, 3-phase, 60-cycle, 900-rpm synchronous driving motor.

High capacity air circuit breakers are provided in the positive and negative leads from each of the 3500-kw main generators, and in the positive leads of each mill and reel motor. The breakers are of the pedestal mounted type, and are installed inside the foundations under the main motor-generator sets. The positive line breakers and positive bus are shown in Figure 9. Disconnecting knife switch, overload relay, and magnetic contactor, are provided in the negative lead to each of the mill and reel motors.

ARRANGEMENT OF MILL DRIVES

The speed and horsepower ratings of the motors for stands No. 1 and No. 2 enable conservative single armature designs, suitable for direct connection to the mill pinion stands. For stand No. 3, the combination of 3500-hp and 225/450 rpm speed range is greater than can be built in a single unit, so that this drive was made as a double armature motor with two 1750-hp units assembled together, for direct connection to the mill pinion stand.

The 3500-hp, 350/700-rpm requirement for stand No. 4, and 4500-hp, 500/900-rpm for stand No. 5, are beyond the limits for even double armature motor designs,

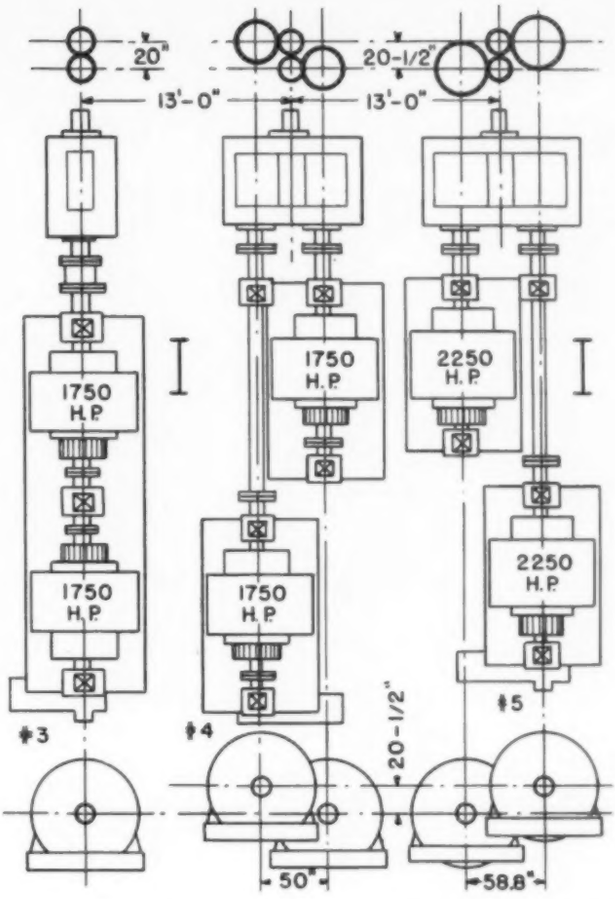


Figure 11 — Shown here is the arrangement of motor drives for stands No. 3, 4, and 5.

Figure 10 — A 4500 hp twin motor drive is used on stand No. 5.

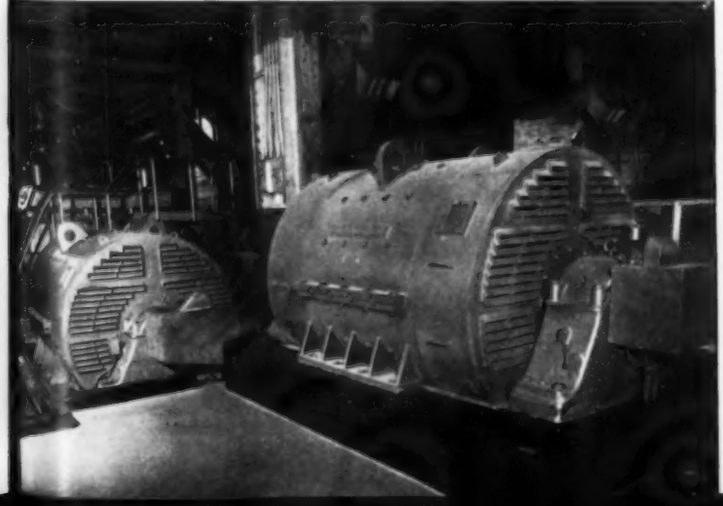
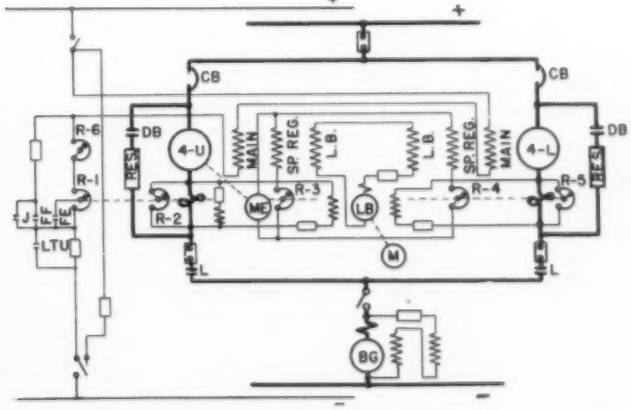


Figure 12 — Schematic diagram of main and excitation circuits for stand No. 4's twin motor drives.



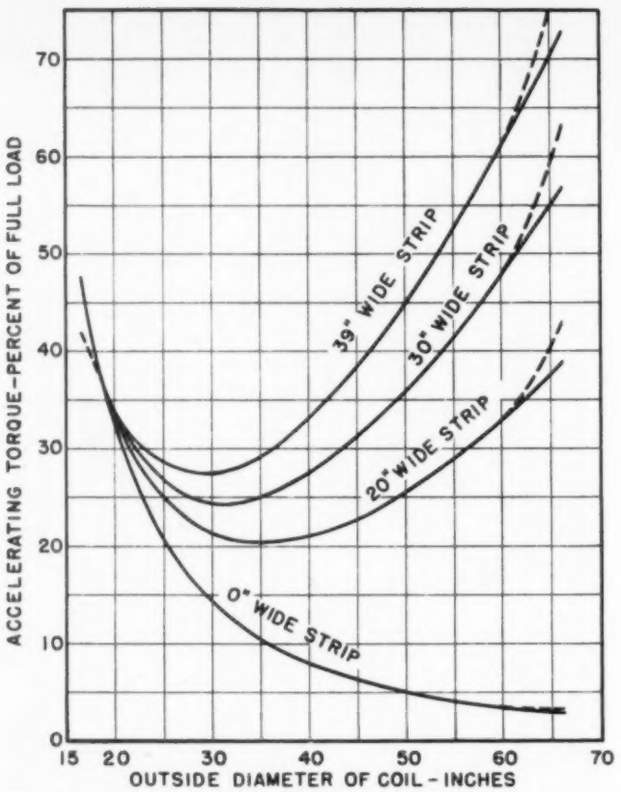


Figure 13 — The torque required to accelerate the winding reel at a rate of 400 fpm per sec is given by these curves for various width strips.

and after consideration of several alternate drive arrangements, decision was reached to use twin-motors, in which the upper and lower mill working rolls are driven by separate motors through speed increasing gears. On stand No. 4 the step-up ratio is 76:49, requiring 225/450 rpm motor speed and enabling the electrical duplication of the stand No. 3 double armature motor. On stand No. 5 the step-up ratio is 98:49, requiring 250/450 rpm motor speed. Figure 10 shows the two 2250-hp, 250/450 rpm single armature motors making up the stand No. 5 4500-hp twin-motor, and Figure 11 shows the plan and elevation arrangements of the drives for stands No. 3, No. 4, and No. 5.

Consideration was given to making each of the 2250-hp motors a double armature machine, however, space limitations would have required installing the two long double armature machines side by side, and the greater center-to-center distance would increase the WR^2 of the offsetting step-up gears by just about as much as the motor WR^2 would be reduced, so there was no justification for the more complex and more costly four-armature arrangement.

The two sets of step-up gears for the upper and lower working roll drives are assembled in a common case, and provision is made for a tie-in gear so that the upper and lower rolls may be driven independently by separate motors, as described, or with the tie-in gear in place in which case the upper and lower rolls are driven together as with a conventional pinion stand. The mill was operated for about three months with the upper and lower rolls of stands No. 4 and No. 5 independently driven, and since last August has been operated with the tie-in gears in place. The tie-in gears were installed as one of the steps to improve the mill operation at a time when troubles were being experienced with roll slippage, however, the operation is not noticeably different and it appears that roll slippage, strip marking, and other random mechanical effects common to all cold reduction mills occur under the same conditions with either drive arrangement.

LOAD BALANCE CONTROL OF DOUBLE ARMATURE AND TWIN-MOTOR DRIVES

Figure 12 is a schematic diagram showing the main and excitation circuits for the stand No. 4 twin-motor drive. Each of the motors has three field windings. The main field windings of the two motors are connected in series and excited from the constant potential excitation bus with adjustment by means of the motor operated coarse adjustment rheostat R-1, and manually operated fine adjustment rheostat R-6. The auxiliary speed regulating windings are excited in proportion to the motor load by the magnetizing exciter driven from the mill motor, with control by rheostats R-3 and R-4, on the same operating mechanism as R-1, to provide the proper series excitation for the best speed regulation at each speed. Balance of load between the two motors is obtained by means of load balancing windings which are differentially connected and excited by the rotating regulator load balancing exciter. The two rotating regulator control fields are excited from the drops in the motor commutating pole and compensating windings, and oppose each other, so that under balanced load the rotating regulator voltage is zero, and no current flows in the motor load balancing field circuit. Any tendency for one motor to carry more than its share of the load results in rotating regulator voltage to circulate current in the load balancing field circuit in the direction to strengthen the field of the more heavily loaded motor and to weaken the field of the more lightly loaded motor, thus restoring the load balance.

MILL WR^2 AND ACCELERATION

Table I shows the calculated WR^2 values of the various rotating parts of each of the mill stands and the reel, and the corresponding torques to accelerate to rolling speed in 10 seconds. The WR^2 values are calculated on the basis of 53 in. diameter back-up rolls and work rolls varying from 19½ in. diameter in stand No. 1 to 20½ in. in stand No. 5, as it is usual practice to use new full diameter rolls in the last stand and older worn rolls in the earlier stands. All WR^2 values are referred to the work rolls. In the next to the last line are given the torques, expressed as a per cent of the motor full load torques, to accelerate from standstill to maximum rated speed in 10 seconds, and in the last line are given the per cent torques to accelerate in 10 seconds to the speeds corresponding to 4500 fpm delivery speed from stand No. 5 when rolling 0.0115 in. thick strip according to schedule "J" on Figure 4.

The significant thing to note in this tabulation is that on stands No. 1 and No. 2 the motor armature con-

TABLE I

Inertia and Accelerating Torque

Five Stand Tandem Tin plate Mill

Stand	1	2	3	4	5	Reel
Motor hp	1750	3500	3500	3500	4500	800
Motor rpm	70/210	125/312	225/450	225/450	250/450	300/1100
Roll rpm	70/210	125/312	225/450	350/700	500/900	300/1100
Diameter—Back-up rolls	53	53	53	53	53	...
Work rolls	19.5	19.75	20.0	20.25	20.5	16.5
WR^2—Referred to work rolls						
Back-up rolls	21,500	22,150	22,600	23,250	23,900	...
Work rolls	3,400	3,500	3,650	3,750	3,900	1030
Spindles	3,500	3,500	3,500	3,500	3,500	310
Pinions or gears	3,200	3,200	3,200	7,450	10,600	...
Coupling (S)	5,250	5,250	3,465	2,800	705	290
Motor (S)	225,000	205,500	56,000	24,100	14,600	4170
Total	261,850	243,100	92,415	64,850	57,205	5800
Per cent torque to accelerate to max speed in 10 seconds	40.7	41.9	33.1	55.8	63.5	54.2
Per cent torque to accelerate to 4500 fpm in 10 seconds. Rolling 0.0115 in. strip—schedule J	27.4	31.3	27.7	45.2	54.8	47.3

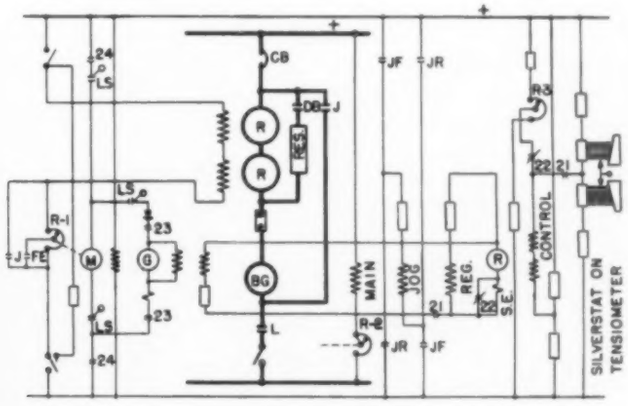
stitutes the greatest part of the total WR^2, however, the speed and hence acceleration rate are low, so that good acceleration performance is readily attained with conventional single armature motor designs. On stands No. 4 and No. 5 the speed and hence accelerating rate are high, and it is necessaary that the motor WR^2 be made as low as practicable, even though the motor represents only 25 per cent or so of the total WR^2. On high speed mills of this type, the per cent accelerating torque invariably is much higher on stand No. 5 than on the other stands, however, this condition can be somewhat improved by making the stand No. 5 motor of larger hp rating than indicated by rolling load calculations. For instance, assuming 4000 hp rolling load, and accelerating to maximum speed in 10 seconds, the motor load during acceleration with the 4500-hp drive is about 152.5 per cent. With a 4000-hp drive, selected on the basis of calculated rolling loads, the motor WR^2 would be reduced by perhaps 10 per cent, but the total WR^2 and accelerating torque would be reduced by only 2.6 per cent. Then the motor load during acceleration would be 169.5 per cent of the full load torque of the 4000-hp drive.

WINDING REEL CONTROL BY REGULATING TENSIOMETER

The winding reel drum is 16½ in. diameter, and the largest coils may build up to 66 in. outside diameter, corresponding to 32,000 pounds of 36 in. wide strip. The WR^2 of the motor and empty reel is 5800 lb ft squared, while the WR^2 with a 66 in. coil of 36 in. wide strip is 131,000 lb ft squared. With this large coil buildup and increase in inertia, the per cent accelerating torque varies over a wide range, as shown by the curves on Figure 13. The lowest curve is on the basis of constant WR^2 as would be the case with a ficticious "zero" width strip, and the other curves are on the basis of the increase in inertia corresponding to 20, 30, and 39 in. wide strip, respectively. All curves are for accelerating to 4000 fpm in 10 seconds. The solid line curves are on the basis of the reel voltage varying in proportion to the strip speed but constant throughout the coil buildup,

Figure 14 — A partially built-up coil is shown on the reel at the delivery end of the 5-stand plate mill.

Figure 15 — Schematic diagram of circuits for winding reel and tensiometers.



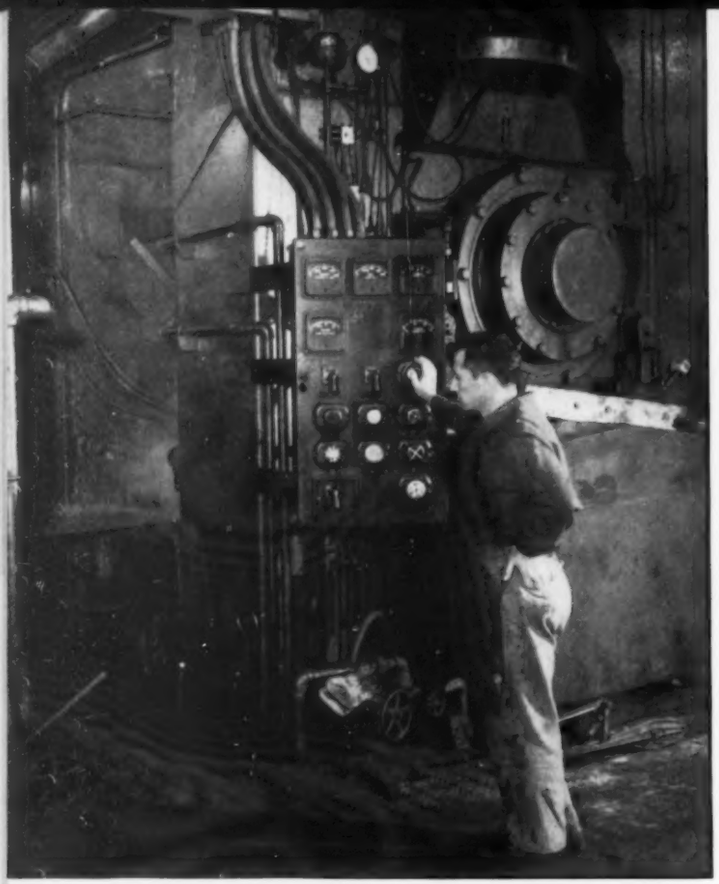


Figure 16 — Indicating type tensiometer is shown on the delivery side of stand No. 2 in this figure and gives a continuous indication of the strip tensions.

while the dashed curves are for the actual modified voltage since the reel motor speed range by shunt field control is slightly less than the coil buildup.

With this large variation in reel accelerating torque, the inertia compensation system for the usual constant current tension regulator would be quite complicated and inaccurate, and it was determined to use a regulating type tensiometer to control the reel. As seen in Figure 14, the tensiometer roll is pressed up against the bottom of the strip between guide rolls installed between stand No. 5 and the reel, and within the limits of tensiometer roll movement the strip tension is proportional to the air pressure in the actuating cylinder, and the tension is adjustable by the setting of the air pressure regulating valve. The tensiometer roll is connected to a regulator which acts through the regulating system to control the reel motor speed and maintain the tensiometer in the fixed position. The tensiometer is responsive only to actual strip tension, hence provides automatic inertia compensation and maintains the same tension during acceleration and deceleration as during operation at constant speed.

The circuits for the winding reel and regulating tensiometer are shown in Figure 15. The 300-kw, 350-volt, booster generator is connected in the reel motor armature circuit, and the booster main field is controlled so that the reel motor voltage is approximately proportional to the strip speed. The regulator, actuated by movement of the tensiometer roll, supplies the intelligence to the rotating regulator exciter which in turn controls the booster generator regulating field and varies the voltage and reel speed to maintain the position of the tensiometer roll. The rotating regulator also energizes the control field of a small variable voltage generator which supplies the operating motor of the reel motor field rheostat, so the reel motor excitation is increased as the coil builds up on the reel, and the reel voltage is maintained essentially constant throughout the rolling of a strip.

Indicating type tensiometers, Figure 16, are installed between stands of the mill, to afford a continuous indication of the strip tensions and guide the operators in proper control of the mill. The tensiometers include palm oil tank and oiler roll to apply and spread palm oil on the bottom of the strip.

METERING EQUIPMENT

Figure 17 shows the front of the duplex meter and control board, which is installed in the basement. On this control board are provided indicating ammeters, voltmeters, and speed indicating meters, in the armature and field circuits of every main and auxiliary machine making up the tandem mill drive. This complete instrumentation has proven of considerable benefit in making adjustments while putting the equipment into service, and to enable the attendant to quickly locate the source of any abnormal operating condition. Graphic recording meters for the main circuits are mounted on the rear panels of the duplex board.

MAIN AND AUXILIARY POWER SUPPLY

Successful operation of the tandem mill at high speed

Figure 17 — The duplex meter and control board is installed in the basement. Indicating meters are used in the armature and field circuits of the main and auxiliary machines making up the tandem mill drive.

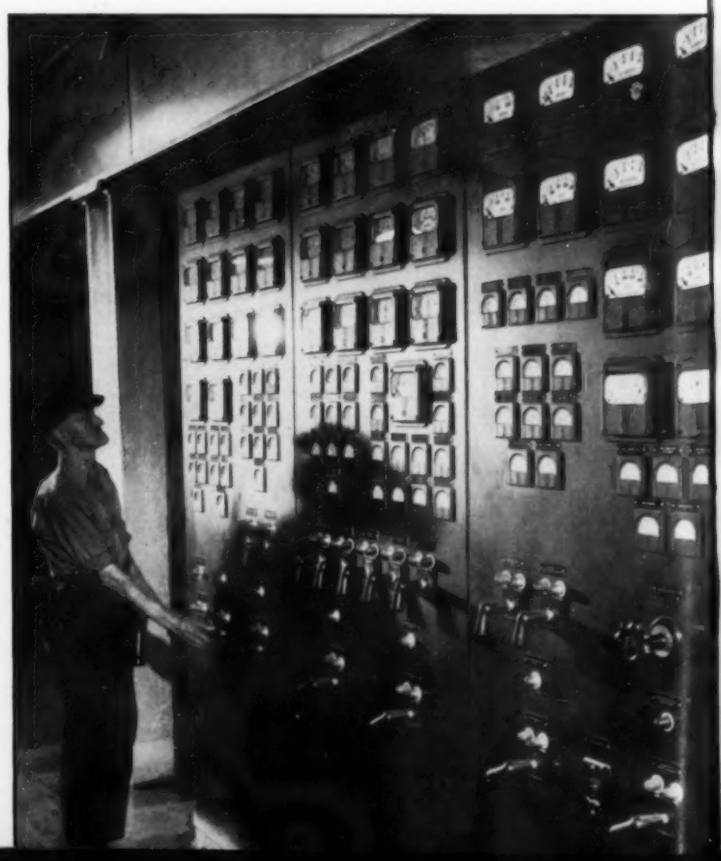
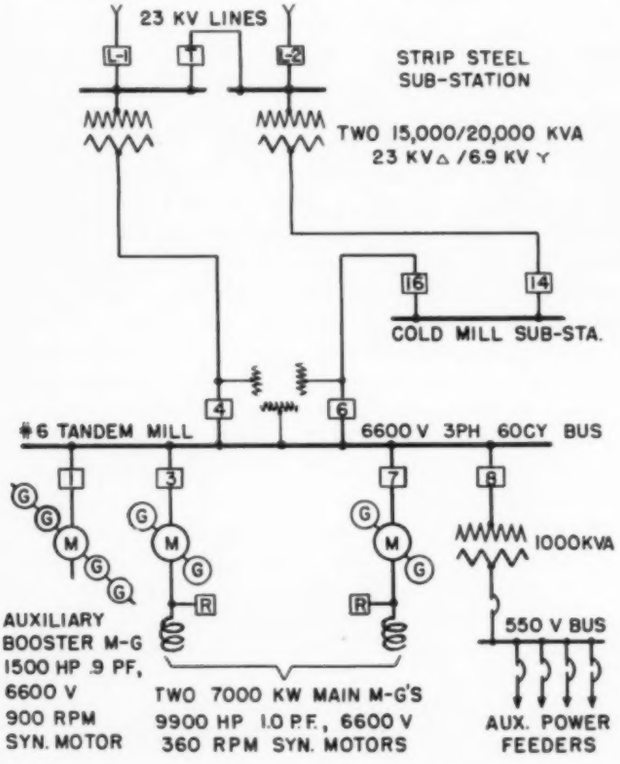


Figure 18 — Power for the 550 volt auxiliary power supply is furnished by a 1000 kva unit substation.

requires careful control of the gear and bearing lubrication, palm oil strip lubrication, water cooling of rolls and strip, machine ventilation, etc. The mill installation includes about fifty-five 550-volt, a-c motors ranging from 1 to 75-hp and totalling nearly 1000 hp, for the drive of oil and grease lubrication, palm oil, hydraulic, and cooling water pumps, coil conveyor, ventilating fans, auxiliary regulating exciter sets, etc. These are supplied from a 1000-kva unit substation, shown by Figure 18, located in the basement control room. The substation consists of a 1000-kva, 6600/550 volt, 3 phase, dry type air cooled transformer and metal enclosed low voltage switchgear with manually operated air circuit breakers in drawout mounting, for the transformer secondary and four feeder and tie circuits.

The high speed tandem tin plate mill, with connected load of about 17,500-kw, represents a major addition to the steel plant power system load. The system load has been still further increased by changes in the hot strip mill to supply the higher tonnage of hot strip. This large load increase necessitated additions to the power generating station and distribution system, and along with the tandem tin plate mill there has been finished

Figure 19 — The primary power supply circuits at the strip steel substation are shown in this diagram.



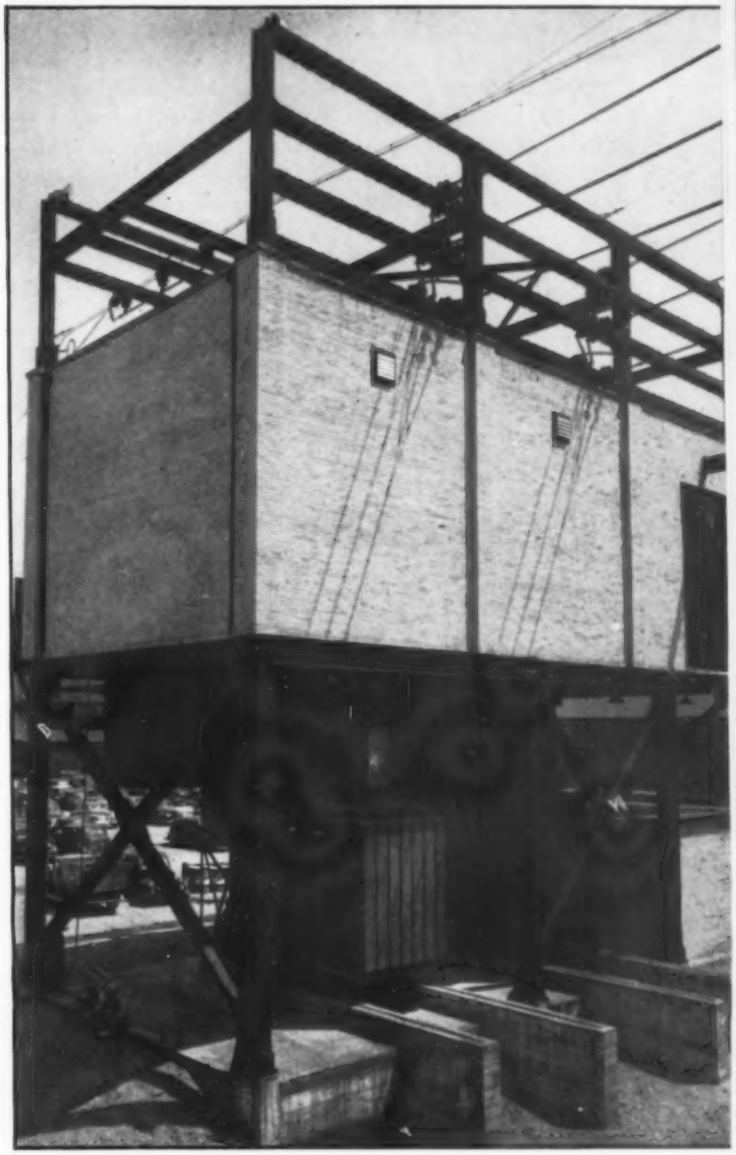


Figure 20 — The strip steel substation has two 15,000/kva 23/6.9 kva three phase transformers.

the first step of the ultimate complete revamping of the primary power system.

The mill loads have increased to the point that power cannot be generated and transmitted economically at 6900 volts, and the new primary power distribution is at 23,000 volts, with stepdown transformer stations at the various mill locations. At the power house there have been installed a new 25,000-kw, 13,800 volt hydrogen cooled turbo-generator unit with solid connected transformer to step up to 23,000 volts, and a 15,000/20,000

kva transformer to tie to the old 6900-volt generating station bus. Two 23,000 volt lines feed load substations at the tin mill and at the strip mill. Figure 19 shows the circuits at the strip steel substation and cold mills. There are installed two three-phase 23/6.9 kv transformers, rated 15,000 kva, continuous self cooled and 20,000 kva with forced air cooling. One transformer feeds the new No. 6 tandem mill directly, the other feeds a substation supplying the older cold strip mills, with a tie to the new No. 6 tandem mill. Figure 20 is a view of the strip steel substation. Provision is made to ultimately extend the station to include six 23-kv incoming lines and six 15,000/20,000-kva transformers to supply the entire load in the strip steel department. The 23-kv oil circuit breakers, of 1,500,000 kva interrupting capacity, are assembled in indoor metal enclosed cubicles, and installed in the brick enclosed switchgear room above the transformers.

The foregoing discussion has described some of the more interesting features of the new tandem tin plate mill, and analyzed the calculations upon which were based the selection of motor ratings, mill operating speeds, type and arrangement of equipment, etc. Expectations as to tonnage output and strip quality have been met in practice. The successful operation of this modern highly powered and complex mill demonstrates the soundness and conservative logic of its engineering design.

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DISCUSSION

PRESENTED BY

C. B. HUSTON, Industrial Engineering Department, General Electric Company, Schenectady, New York

R. T. LUCAS, Assistant Electrical Superintendent, Weirton Steel Company, Weirton, West Virginia

C. B. Huston: First, in regard to the capacity of the motors on the mills. It might be inferred from the figures that Mr. Kenyon has given that the mill at Jones and Laughlin Steel Corporation, Aliquippa works, equipped with one of our drives, is underpowered as compared to the Weirton mill.

Now at the Weirton mill, as Mr. Kenyon has told you, the duty cycle was chosen on the basis of rolling tin plate 36 in. wide at 4500 fpm. The duty cycle for the J & L mill was on the basis of rolling strip 32 in. wide at the same speed, namely, 4500 fpm. The ratios of those two horsepowers on the last stand, 4000 for the one and 4500 for the other, are in direct proportion to the change in basic schedules for the mills. For higher speeds it was conceded that strips of narrower widths would be handled, or perhaps lighter schedules rolled, where strip would be entered at a lighter gage to begin with.

The two mills are just about equally powered, and from the experience that Mr. Kenyon has told you, they are quite justified in their choice of rating on the Weirton mill, and I believe that we can say the same about the Jones and Laughlin installation.

Just one further note in regard to the use of a double armature twin drive or a single armature twin drive for the last stand. That is the one basic difference between the drives at Aliquippa and at Weirton. The distance between centers on the gear units were fixed by the mill builder, and with those centers fixed, the proportions of the gears themselves determined the amount of WR^2 in those units. We then had only to pick the combination of motor unit which would result in the least additional WR^2, for which we found with the double armature twin we saved about 13 per cent in accelerating torque.

Incidentally the motors as well as the generators are equipped with high temperature insulation and are capable of the same overload ratings that Mr. Kenyon has disclosed to you on their equipment.

The second point is with reference to a common bus, or single generator operation. This question of the selection of generators was given serious consideration as far back as 1939 on the No. 2 Irvin mill. We did not make up the complete proposition, but we made a hasty survey of the relative prices on the generating equipment for the two combinations, and found that the balance was still a little bit in favor of the common bus.

When these later mills came along, Jones and Laughlin in particular, the size of the units were such that the single generator scheme most naturally fitted into the picture. Mr. Kenyon has already outlined the advantages of this system. We considered that, regardless of the complexity of the regulating system, or the high degree of adjustment needed for such a system, the electrical manufacturer was duty bound to proceed with development along that line.

As a result, we not only built the Jones and Laughlin mill with the single generator scheme of control but five others. These are the Great Lakes Steel Corporation three-stand mill already in service; the Carnegie-Illinois Steel Corporation four-stand mill at Gary, already in service; the Columbia Steel five-stand mill on the Pacific Coast which will go into service sometime during the summer of 1949; the Carnegie-Illinois Steel Corporation three-stand mill will follow a little later, and last from the point of service, will be the Inland Steel Company five-stand mill. All six of these mills have the individual generator.

Naturally, no electrical manufacturer would tackle so many drives all at the same time, all with a special

feature of this sort, if we did not have full confidence in their design. There has been some need for careful adjustments when placing the equipment in service, but it has not been an unduly complicated job. After all, the regulating system on the single generator control, individually, is no more complicated than you will have on the voltage regulating system of a group control. You have more systems, but that does not necessarily mean greater complexity. We feel fully justified in having proceeded on this basis, and I am sure that the operating companies will bear us out in that respect.

One further word in regard to the individual generator control. The value of excitation required by the individual generators is reduced to such point that a regulating exciter may be used to excite the generators direct, and in this way you save working through a medium of a large supplementary exciter. As a result the voltage regulating system is easier to stabilize.

Incidentally, the Great Lakes Steel Corporation mill, which was the second equipment to go into service, was being pushed to the limit for early production and the electrical equipment was turned over by the contractor for adjustments only 4 days before we were supposed to be rolling steel. On the fourth day the mill was placed on two-turn production schedule. The equipment surely is not too complicated, otherwise an accomplishment of this sort could not have been realized.

On point number 3 we have pretty well all agreed. Both operating people and electrical manufacturers believe that IR drop compensation is essential for the successful operation of these high speed mills. The electrical manufacturer will strive to obtain a characteristic in the design of motors such that approximately equal rpm speed change is obtained at all speeds. This will allow the motor speeds to follow the IR drop line, and with this characteristic the IR drop compensation readily produces the same results at all speeds or field adjustments of the motors. Our company has obtained the desired motor characteristics without the use of separate exciters.

Incidentally IR drop compensation is very easily obtained with individual generator control. It is necessary only to introduce one small machine into the regulating circuit which will regulate the IR voltage drop compensation as a function of the current load of the motors.

Point 4 is load balance between top and bottom rolls. The mill at Aliquippa is designed with gear units where no idler gear can be used between the top and bottom rolls. Therefore, we are forced to use the load balance, and I am sure that the operating experience has been that no difficulty in this regard has been encountered. And as a matter of fact, I am told that they no longer pay strict attention to choosing the top and bottom rolls of exactly the same diameter. In other words, the tolerances are not held to the close limits that you otherwise need if you have your rolls tied mechanically together. Individual drive on top and bottom rolls I am sure is something we shall be confronted with more and more in these high speed mills.

No. 5 and last is in regard to tension reels. We have used tensiometers on slower speed mills for some time. For instance, in 1942 at the Warren plant of Republic Steel Corporation there was placed in service a three-stand mill followed by a tensiometer between the mill and the reel. That has operated successfully since that date. Prior to this in 1940, the American Steel and Wire Company at Cleveland equipped their reversing Rohn mill with tensiometers of our design that regulated tension. These have operated successfully, although it is quite true that the speeds are quite low compared to what you have seen at Weirton on their new mill.

A tensiometer of course is a position affair. It has to move in order to communicate a signal to the electrical system. The mechanics of the system may need in some way be dampened, such as with dashpots. The tensiometers are naturally troublesome to mount. The mill manufacturer does not like to bother with them. The operating people likewise do not like to maintain them, and usually say that if there is any other way to do the job let's do so. The Jones and Laughlin mill has both current and tensiometer control of tension. So far current control only has been used for regulating tension. The tensiometer has been used for indication only. I am not here to say which is the best. We cannot lose sight of the fact that current produces torque, torque produces tension, therefore, if we can operate the reels by working direct from current to tension without passing through mechanically operated equipment, we are much better off.

R. T. Lucas: On one of the illustrations is shown what we call the duplex panel, which consists of more than a hundred meters. In our original installation of No. 4 tandem mill back in 1939, we had almost the same equipment except for one stand, and we had about four meters per cabinet, and in our basement we had none to tell us what we were doing. So during the discussions with control manufacturer and Weirton Steel, the electrical manufacturer was asked to provide a small meter cabinet so our maintenance men would know what they were doing. We talked about it considerably, and that small meter cabinet grew into a piece of equipment that was a major piece of the installation. It is more than six feet long with two sides, as the word, duplex would signify, and there are over a hundred meters on this cabinet. Our operators can stand down there and tell at a glance if the mill is operating correctly or where the source of trouble is located.

We have meters in every circuit that we think is necessary for operation of the mill.

Another feature that is important, on our stand cabinets, we have field ammeters for the motors. Normally, to set up a mill for different rolling speed, it is required to raise the mill to top voltage and set the speed of the roll stand according to the set-up required for the gage that we are rolling. By addition of field ammeters on the cabinets, that has become a problem that we do not have to worry about any more. The rollers on the mill set the mill speeds, or set the field current of the motors for certain orders. We have those orders and field currents tabulated, so that if we are rolling 0.006 or 0.093 or 0.010 or 0.012 in., those field currents are tabulated and by setting the field currents on the ammeters it is possible to set the mill up while the strip is being fed through the mill. That has, I believe, increased our production, it has saved a lot of time, and it is another indication of what you can do by applying meters in the right place.

Heat Transmission IN

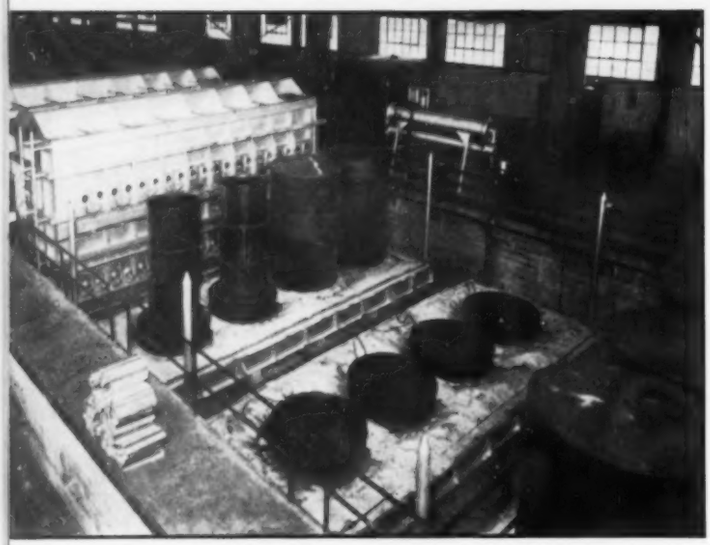

Figure 1 — A typical arrangement of annealing coils and inner covers is shown in this photograph.

. . . . the important factor in heat transfer of coils is the conduction through the film and not the radiation or metallic contact as is usually assumed . . . .

▲ THE liftable or portable annealing furnaces which came into general use about 1933, having radiant heating tubes along the sides, were intended for annealing sheets in piles, as was then the universal practice. When the rapid change-over to annealing strip in coils occurred about 1939, the annealing practice was transferred directly from sheets to coils; the same equipment being available was used, and has been continued in use without important change until very recently; although for coils, this method represents the most difficult way to heat. For piled shets, it was very good since the thermal conductivity of these is excellent for heat flow in the horizontal direction, or from the sides of the pile, equal to that of solid steel, and averaging about 25 Btu per sq ft, per hour, per degree F, per foot thickness.

With coils, placed with axis vertical, for flow of heat in the radial direction or perpendicular to the layers or wraps of the strip, the conductivity is very poor, only about 1¼ Btu per sq ft, per hr, per degree F, per ft thickness, or not much greater than that of firebrick, for example; while the thermal diffusivity, which is the factor that governs the equalization of temperature throughout the coil, is only about half as great as that of firebrick. To add to the difficulty of transferring heat and equalizing temperatures, in most cases the coils are not heated all around, but are arranged usually in rows of four, and heated from two opposite sides only; each coil partially blocking off the radiation to its neighbors on the sides at 90 degrees from the heating tubes. Yet, in the practice which has been universal until within the last two years, at least ⅚ of the heat is put into the coils radially, and only about ⅙ is put in through the ends of the coils, by heat flow in the axial or vertical direction. It seems that the practice has been determined solely by convenience of handling the coils, without regard to the best method of heating.

Figures 1 and 2 show the usual arrangement of coils, which are piled 3 or even 4 high, with outside diameters of 44 to 54 inches, the inside diameter being usually 20 inches, for coils of tin plate strip having a thickness of about 0.010 inch and a width of 29½ or 30 in. Coils with outside diameters of 56 inches to 72 inches and inside diameter usually 30 inches, are used for auto body stock having a thickness of about 0.035 inch and width up to about 96 inches. Usually in present practice, two rows of coils are arranged side by side, 4 coils long, or 8 coil-stacks per annealing cover, with heating tubes at the sides and between the two rows.

Making actual temperature measurements in such coil-stacks during annealing is difficult, but a few tests have been made, and the results of one such test are shown graphically in Figure 3. They apply to coils of tin plate stock, with 44 in. outside diameter, 20 in. inside diameter, 29½ in. wide, piled three-high. The thermocouples were located as indicated in Figure 2.

From analysis of these actual temperature measurements, the thermal conductivity in the radial direction was found to average 1.28 Btu per ft, per hr, per degree F. In considering the mechanism by which radial heat transmission can occur within the coil, radiation is the first means which comes to mind, and the impression seems to be quite general that radiation is indeed the chief factor in heat transfer from layer to layer in the coil. Numerical calculation from known radiation constants, however, shows that actually radiation can account for only a very small, in fact a negligible percentage of the total heat transfer. Cold-reduced steel strip has a fairly bright and reflective surface, which is preserved by the protective gas atmosphere used in annealing. At least two independent sets of tests show that the emissivity of the surface averages 21.6 per cent of that of the ideal "black body," and for radiation from one such reflecting surface to another similar parallel surface, the factor becomes 12.1 per cent. The coefficient of heat transfer then ranges from 0.15 Btu per sq ft, per hr, per degree F at a temperature of 100 F, to 1.68 at 800 F and 4.57 in the same units at 1300 F. When it is considered that in coils of strip of tin plate gage, there are about 100 wraps or layers per inch of thickness, and therefore 100 radiation jumps per inch, it will be evident that so far as radiation is concerned, the laminated coil structure constitutes almost an ideal heat-insulator; its average equivalent thermal conductivity is only 0.0014

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STRIP-COIL ANNEALING

By J. D. KELLER
Associated Engineers
Pittsburgh, Pennsylvania

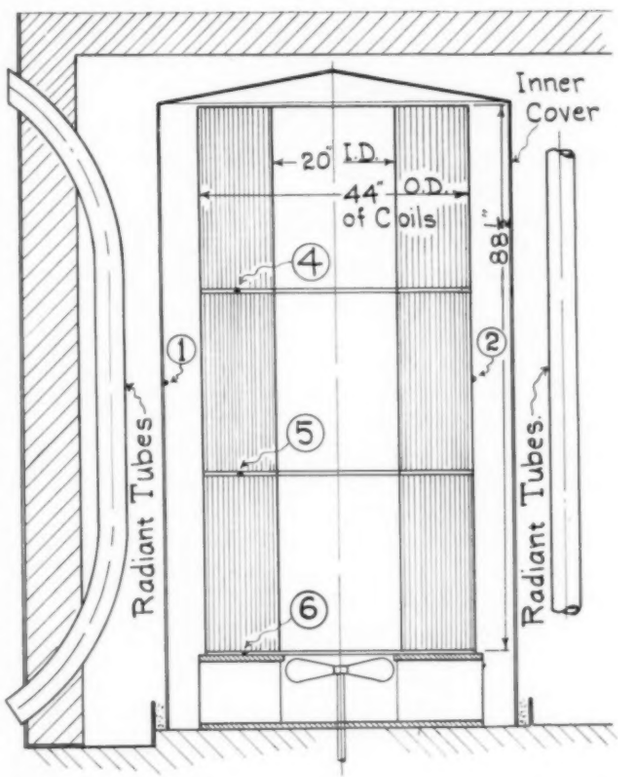


Figure 2 — The coil setup shown here is normally used for tin plate strip. Thermocouple positions for a test are shown by the circle numbers.

Btu per ft per hr, per degree F, or less than ⅛ of one per cent of the total. In coils of auto body stock, having only about 29 layers per inch of thickness, radiation still accounts for only about $^{4}/_{10}$ of one per cent; and even as an extreme hypothetical condition, if the surfaces of the auto body strip were completely oxidized, radiation still could account for only about 2½ per cent of the total apparent radial conductivity.

An impression also seems prevalent that actual metal-to-metal contact of adjacent layers accounts for a large part of the heat transfer, and this mechanism has therefore been subjected to thorough analysis. The data from which to work consist chiefly of studies and test data on electrical conductivity at contact points of surfaces, but include one set of tests of actual heat transfer across contacting surfaces of various metals.

R. Holm [1]* made an exhaustive study, both theoretical and experimental, of the resistance of electrical contacts, from which it appears that actual metal-to-metal contact occurs in a comparatively small number of almost microscopic areas, called "a-spots," having an equivalent diameter averaging about 1½ thousandths of an inch; and that the resistance to flow, whether of electricity or of heat, is due to the "constriction resistance" resulting from convergence of flow into these spots, which comprise only a minute fraction of the total surface area.

The resistance varies with the pressure exerted on the surface, but not to a great extent (usually inversely as about the $^{6}/_{10}$ power of the pressure). For rigid contacts, the number of contact points is found to be only from 4 to 10, regardless of the area, but for moderately flexible contacts such as steel strip, the number must evidently bear some proportion to the total surface area.

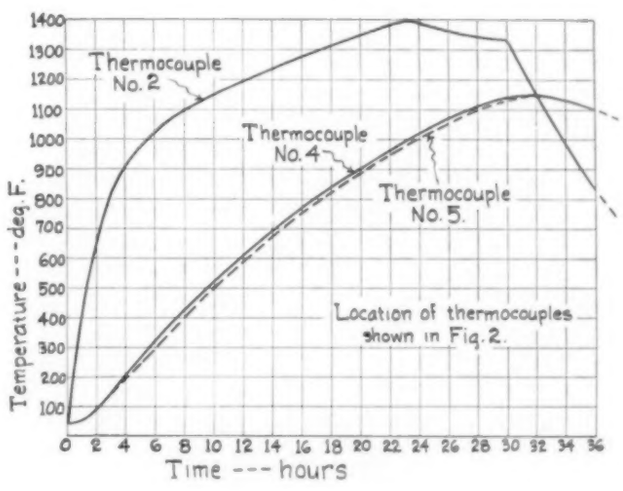
Bowden and Tabor [2], studying surface contacts in relation to solid friction, carefully determined by electrical measurements the actual contact area of flat steel surfaces of 21 sq cm area. Under a load of 20 kg, corresponding to an average pressure of about 13.6 psi, the fraction of the microscopic area actually in contact was found to be 1/10,000.

Jacobs and Starr [3] measured the actual thermal conductivity of very clean contacts of copper, silver and gold, under various pressures, in a vacuum chamber. The surfaces were polished to approximately optical flatness.

Definite figures as to the tension under which strip is coiled seem to be unobtainable, but probably it does not exceed 50 per cent of the yield point, or say 16,000 psi. The average radial pressure, in coils of tin plate gage, due to the coiling tension would then be about 10 psi. Correcting the three sets of data, where necessary, in proportion to the physical constants of soft steel, the values of thermal contact-conductance under this pressure range as follows:

*Figures in parenthesis refer to bibliography at end of article.

Figure 3 — The temperatures given by the thermocouples shown in Figure 2 at various times in the annealing cycle are shown in this diagram.



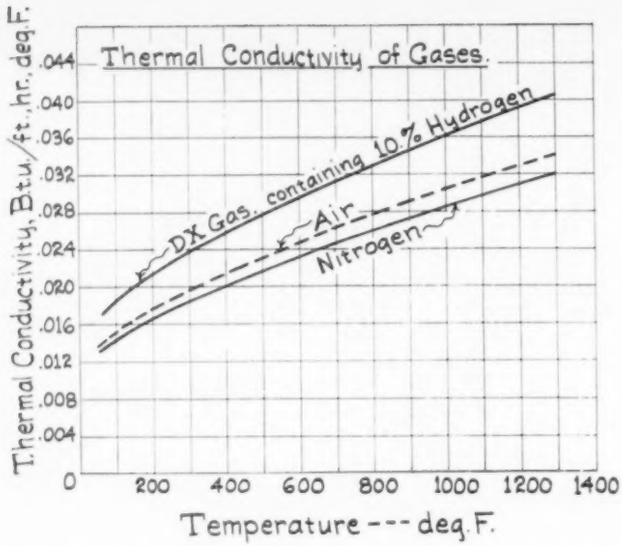


Figure 4 — The thermal conductivities of DX gas, air, and nitrogen are very close to each other.

12.7 Btu per sq ft per hr per degree F, based on the data of Bowden and Tabor, with Holm's value for the radius of the *a*-spots;

13.4 Btu per sq ft per hr per degree F, based on the tests of Jacobs and Starr with copper contacts;

25.4 Btu per sq ft per hr per degree F, based on Holm's figures for 1000 grams load on contacts of 1.42 sq cm microscopic area;

45.5 Btu per sq ft per hr per degree F, based on Jacobs and Starr's tests of silver contacts;

65.8 Btu per sq ft per hr per degree F, based on Jacobs and Starr's tests with gold contacts.

For coils of strip of tin plate gage, having 100 wraps or layers per inch thickness, these figures correspond to a range of thermal conductivity due to contact, from 0.0106 to 0.0548 Btu per ft per hr per degree F. Since Jacobs and Starr's contacts were optically plane, in other words much smoother than rolled strip, the conductivities based on their tests are evidently on the high side; and for strip, the most probable value is believed to be about 0.025 Btu per ft per hr per degree F, or slightly less than 2 per cent of the total equivalent radial conductivity. Even the highest value, however, would represent only about 4½ per cent of the total. The heat transfer which can be accounted for by metal-to-metal contact, therefore, while by no means negligible, still is only a minor part of the total.

How then can the remaining part, or probably almost 98 per cent, be accounted for? The answer is that it results from thermal conduction through the thin films of gas which fill the spaces between the layers. Coils are ordinarily wound 97 to 97½ per cent solid, which means that the gas films between the layers of strip occupy only 3 to 2½ per cent of the volume; but this 3 per cent for all practical purposes determines, alone, the radial thermal conductivity of the coil.

The gas between the layers or wraps of strip initially is air, since the coiling is done in air. After the start of annealing, as the coil heats up, a small proportion of gas may be driven out of the pores of the steel. Although test data seem to be lacking, the gas will probably be hydrogen from the pickling. At a temperature of probably 600 F, this gas would react with the oxygen of the air films, leaving nitrogen and water vapor. (Since water vapor if present in any but minute quantities affects adversely the surface of the steel, it is evident that the amount of hydrogen coming from the steel must be negligible). At higher temperatures, the remaining oxygen probably reacts with the steel, forming an imperceptible layer of oxide on its surface, leaving the nitrogen to fill the spaces. The gas films probably thenceforth consist of nitrogen, until the cooling part of the cycle, when the contraction of the gas will cause some of the DX gas atmosphere to be drawn into the spaces between the layers of strip.

All of these gases have thermal conductivities of about the same order of magnitude, as shown in Figure 4, and the average for the entire annealing cycle can probably be taken as that of air at about 800 F, or 0.0277 Btu per ft per hr per degree F. For strip $\frac{1}{100}$ in. thick, with gas films 3/10,000 in. thick separating the layers, if the film thickness were uniform the equivalent

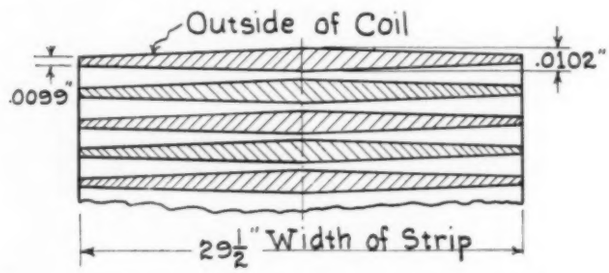


Figure 5 — The thickness of the strip is not uniform, but is shaped as illustrated by this figure, which exaggerates the variance.

thermal conductivity due to conduction through the gas films and the steel layers in series would be 0.892 Btu per sq ft per hr per degree F per foot of coil thickness. This would account for only 70 per cent of the actual radial conductivity.

The assumption of uniform thickness of gas films is, however, far from correct. In the first place, the strip is not perfectly uniform in thickness; its cross-section is usually lozenge-shaped, as shown (exaggerated) in Figure 5. Strip of tin plate gage is usually 0.0002-0.0003 in. near (but not exactly at) the edges, with a fairly linear taper; and it follows that the gas films are thicker by the same amount. Then the gas-film thickness, (averaged circumferentially), would be 0.000175 in. in the middle and 0.000425 in. near the edges. From the location of the thermocouples shown in Figure 2 it is evident that these indicated the temperature at top and bottom of the coils, that is to say at the edges of the strip. The radial conductivity corresponding to 4¼ ten-thousandths in. would be 0.637 Btu per ft per hr per degree F, or only 50 per cent of the total.

But the gas films are not of uniform thickness in the circumferential direction, either. A certain amount of waviness of the metal surfaces always exists, and it can be shown mathematically that the effect of this is to increase the average conductivity, often very greatly, depending on the form of the waves and the ratio of their height to the average film thickness. For longitudinal waves of sine form, as sketched in Figure 6-a, mak-

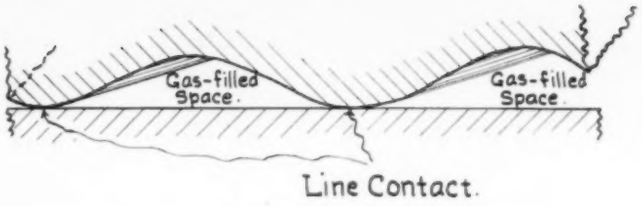


Fig. 6-a.

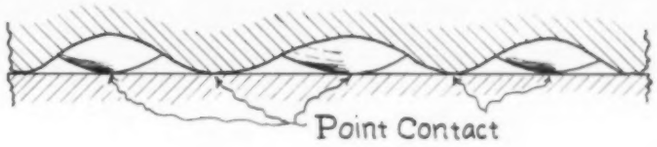


Fig. 6-b.

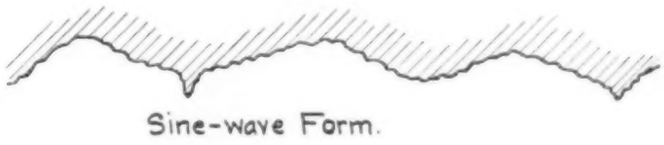


Fig. 6-c

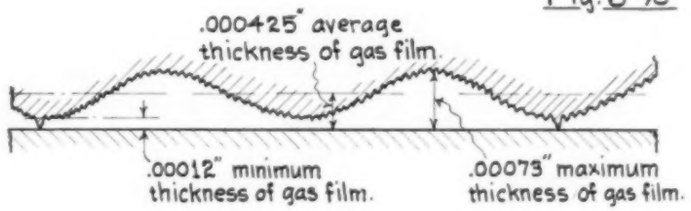


Fig. 6-d.

Figure 6 — Four assumptions on the manner in which one layer of strip contacts the other is illustrated in this sketch. The form given in Figure 6-d is probably closest to the actual condition.

ing actual line contact with the opposite surface, the conductivity is 3.5 times as great as if the gas film thickness were perfectly uniform. But if, instead, the waves have the form of dimples and mounds, as sketched in Figure 6-b, of the form of paraboloids of revolution making point contact at the apices, then the multiplier is only 1.86.

Neither of these, however, quite corresponds to the actual form of the metal surface waves. Profilometer measurements do not seem to have been made on cold-rolled surfaces, but may have been made on ground and other finely finished surfaces, and these very generally show chiefly longitudinal waves of either saw-tooth or sine wave form, but with points or peaks projecting from the crests of the waves at intervals, as sketched in Figure 6-c. For finely ground surfaces the distance which the peaks project above the average height of the surface near them is usually about 120μ, or 0.000120 in.

The probable wave form and proportions are then as shown (much exaggerated as to vertical dimensions) in Figure 6-d; the multiplier is found to be 1.40, and the radial conductivity is 1.40 x 0.892 Btu per ft per hr per degree F at the edges of the coil. At the middle of the strip width, or middle of height of coil, the average film thickness of 0.000175 in. differs so little from the minimum thickness of 0.000120 in. as to indicate that practically no waviness exists there. In other words, the coiling tension is chiefly concentrated at the middle of the strip, and this almost eliminates the waves there, producing practically uniform thickness of the gas film. The multiplier exceeds unity by only a negligible fraction, and the radial conductivity due to the gas films is 1.493 Btu per ft per hr per degree F.

The accounted-for radial conductivity values due to the various factors then are as shown in the following tabulation, for strip of $\frac{1}{100}$ in. thickness.

Taking the figure for 800 F as representing the average, we have now accounted for $0.915/1.28 = 71\frac{1}{2}$ per cent of the actual radial conductivity near the ends of the coils. Or, if the coil is $97\frac{1}{2}$ per cent solid instead of 97 per cent, the figure becomes $0.96/1.28 = 75$ per cent of the total. The difference between 0.915 (or 0.96) and 1.28 Btu per ft per hr per degree F is believed to be accounted for by a combination of axial and radial flow

TABLE I

Accounted-for Radial Conductivities

	Near edges of coil			At middle of height of coil		
	100 F	800 F	1300 F	100 F	800 F	1300 F
Due to radiation	0.0001	0.0014	0.0038	0.0001	0.0014	0.0038
Due to metallic contact*	0.025	0.0213	0.0166	0.025	0.0213	0.0166
Due to gas-film conduction (coil 97 per cent solid)	0.504	0.892	1.092	0.844	1.493	1.827
Total, Btu per ft per hr per degree F	0.529	0.915	1.113	0.869	1.516	1.847

*Note: The contact conduction must actually be greater at the middle and less at the edges than the figures shown, because of greater-than-average tension and radial pressure at the middle.

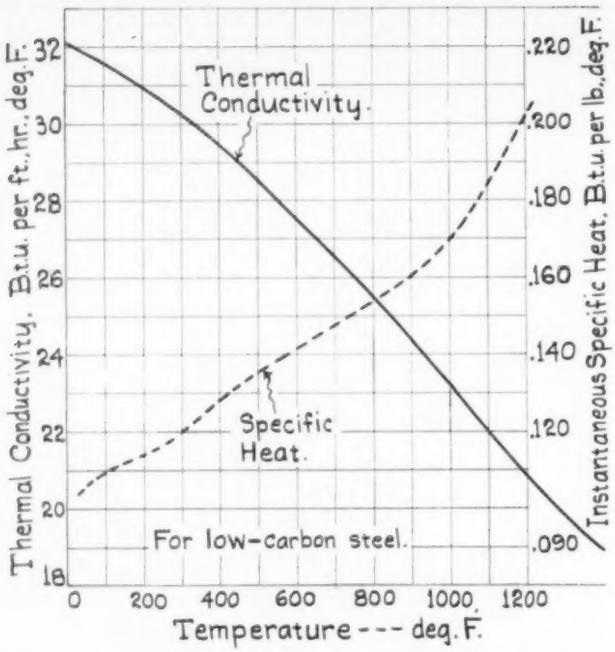


Figure 7 — Thermal conductivity of low carbon steel decreases with the temperature, and the specific heat increases with the temperature.

of heat; the heat penetrates more rapidly by radial flow at the middle of the coil height than at the edges, the temperature at any radius becomes higher at the middle of the height, and part of the heat thus conducted radially then flows axially from the middle toward the end (except at the top and bottom of the coil stack.)

For auto body stock, of 3½ times the thickness of tin plate stock, the radiation component would be increased in about that ratio, the contact component would be increased to a lesser extent, but the gas film conduction should remain practically unchanged, and the total should differ little from that of tin plate coils. Actual test data on coils of auto body stock have not been available.

Figure 7 shows the conductivity and the specific heat of low carbon steel, as related to temperature, and Figure 8 shows the thermal diffusivity calculated therefrom, for solid steel, corresponding to axial heat flow in coils, and the same for radial conduction in tin plate coils near their edges.

The fact that almost 98 per cent of the radial conductivity in strip coils is due to gas film conduction, suggests the thought that much more rapid heating and cooling might be effected if a gas of higher thermal conductivity could be used. Pure hydrogen has the highest thermal conductivity of all the known gases, almost seven times the conductivity of air. This does not mean that the mere substitution of hydrogen for air or DX gas would reduce the heating time to ⅐, for the bottleneck would then be shifted to the transmission of heat to the coil surface. Furthermore, the mere presence of hydrogen around the coils would not do; the gas between the layers or wraps of the coils would have to be totally replaced by hydrogen, and this would require either coiling in a hydrogen atmosphere or, more probably, forcing the hydrogen into or through these spaces under pressure. However, hydrogen is a very penetrative gas, and no difficulty should be encountered in getting it into the "void" spaces in the coils. Other gases of high thermal conductivity are the gas mixture produced by dissociating ammonia, containing 75 per cent hydrogen and 25 per cent nitrogen by volume, and having a thermal conductivity four times that of air, and helium, which according to the Landolt-Bornstein tables has a conductivity 5¾ times as great as air.

For some time the author has been suggesting the use of hydrogen in the manner described, but many operating engineers seem to feel that its use would entail the danger of spoiling the surface of the strip, or causing blisters, or hydrogen embrittlement. On the other hand, practically every metallurgist with whom the matter was discussed was positive that no deterioration of the strip surface would be caused by the use of hydrogen, unless the surface was initially oxidized or rusty. In view of the very great reduction of heating and cooling time to be expected from the use of pure hydrogen in the void spaces of the coils, tests at least would seem to be in order, but such tests would have to be

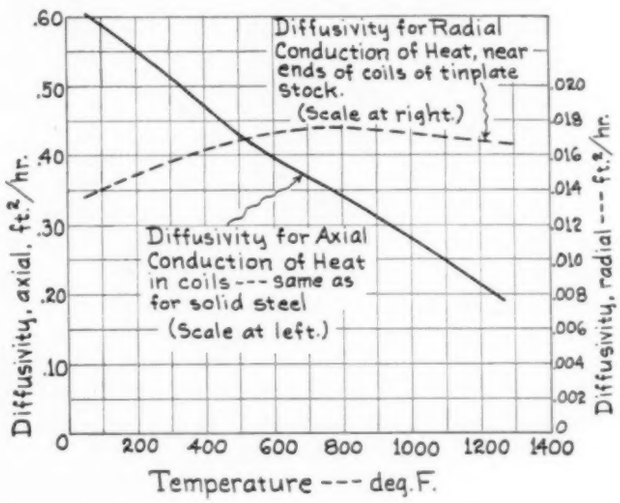


Figure 8 — Radial and axial diffusivity for coils is given in this photograph.

made in a scientific manner. The use of helium might be considered if that gas can be obtained in sufficient quantity and at not too high cost; it certainly could have no deleterious effect on the strip.

Certain other valuable heat transfer constants in addition to the radial conductivity can be obtained from the analysis of the test data shown in Figure 3. For example, these show that the "pole temperature," toward which the temperatures were all approaching during the heating period, was 1650 F, representing the average radiant-tube temperature; and that the overall heat-transfer coefficient from the tubes to, through, and from the "ash can" inner cover to the circumferential surface of the coils, is the same as that calculated from the Stefan-Boltzmann radiation equation with an equivalent emissivity equal to 9.96 per cent of the ideal black-body value; or, in Btu per sq ft of circumferential coil surface per hr per degree F temperature difference between the heating tubes and the coil surface, the heat transfer coefficient is:

$$\text{Heat transfer coefficient} = \frac{0.0172 \times \left[21.10^{4} - \left(\frac{T_s + 460}{100} \right)^{4} \right]}{(1650 - T_s)}$$

where T_s = temperature of coil surface, degree F

For the top and bottom surfaces of the coil stack, the coefficient in this test did not follow the radiation law, but remained fairly constant at 2.7 Btu per sq ft per hr per degree F for the bottom of the lowest coil, and 3.2 in the same units for the top of the uppermost coil (the temperature difference being that between the 1650 F tube temperature and the temperature of the bottom or top surface of the coil).

The effect of the circulating fan was also studied. These fans (not the powerful ones now used with convectors) produced a velocity of only about 10 to 12 feet per second through the inside of the coil stack, and 3 to 4 feet per second along the outside of the coils. Calculation agreed with test data in showing that these fans effected a shortening of the cycle amounting to only 6 or 7 per cent. Their chief function was to produce quicker heating in the lowest coil in the stack.

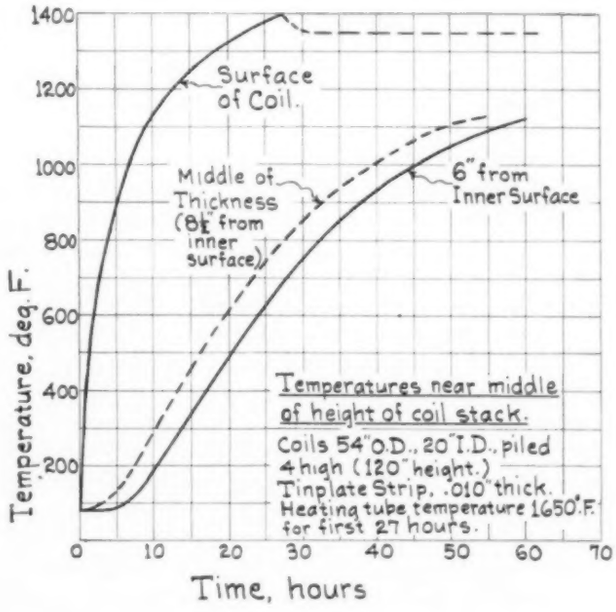
The reason for deriving the various surface heat transfer coefficients and the conductivity and diffusivity values is, of course, to enable the heating and cooling cycles to be calculated for coils of any other diameters and piling height. In order to utilize the data, a method of calculating the temperature rise due to both radial and axial heat flow had to be devised. For calculations where especial accuracy is required and where a commensurately long time can be expended in the figuring, a combination of the Emmons method [4] and the Schmidt numerical method [5] may be used. The author has used this combination method in some cases, but it is extremely tedious and time-consuming. Resort was therefore made to the method of A. B. Newman [6], who showed that in the case of finite cylinders with heat transfer to both the circumferential area and the ends, the uncompleted-temperature-change fraction is equal to the product of the factor for the ideal cylinder of infinite length, times the factor for the ideal slab of infinite extent and of thickness equal to the length of the actual cylinder. This holds true even if the radial conductivity differs from the axial conductivity, and if the surface heat transfer coefficient for the circumference differs from that for the ends; the only requirements being that both have the same "pole temperature," and that the surface heat transfer coefficients remain constant. The latter condition is not fulfilled in the case of strip coil annealing, since the radiation heat transfer coefficient for the circumferential area increases very considerably as the surface temperature goes up. Nevertheless, it is believed that the departure from strict correctness, due to this variation can cause little error in the final result.

By using the Newman method with the Schmidt graphical method [7], the calculations can be made with reasonable speed. Figure 9 shows the results thus obtained for coils of 54 in. outside diameter or 17 in. thickness, piled four high, or to 120 in. total height. While no data are available as to variation with diameter of the coefficient of heat transfer to the ends of the coil, it seems reasonable that this should decrease as the coil diameter decreases; and the end coefficients have been assumed to be inversely proportional to the coil diameter.

Figure 10 shows the increase of heating time with coil diameter, as calculated by the method outlined. For points at the middle of the thickness, or halfway between inside and outside surface, the broken-line curve (1) applies, and based on it, the heating time would vary about as the 1.5 power of the thickness. By thickness is meant one-half (outside-inside diameters). Since the heat transfer to the inner surfaces of the coils is negligibly small, the temperature probably will decrease from the middle point to within a few inches from the inner surfaces. Hence, for equally good annealing in coils of different outside diameters, the comparison should be made between points at a given distance from the inner surface, rather than at the middle of the thickness. Since the thermocouples in the test of the 44 in. outside diameter coil were at 6 in. from the inner surface, this has been taken as the point of comparison for the other diameters, and the solid-line curve (2) in Figure 10 was thus obtained. Based on it, the required heating (or heating-plus-soaking) time varies about as the 1.8 power of the coil thickness.

The calculations showed further that so far as points near the middle of the height of the coil stack are concerned, an equivalent or apparent radial conductivity can be determined, and the ordinary Schmidt graphical method as modified for cylinders [7] can then be used alone, without reference to the end conduction. By this method, results of quite sufficient accuracy can be obtained in a much shorter time. The equivalent radial thermal conductivity was found to be 1.53 Btu per ft

Figure 9 — Calculated time-temperature curves shown were computed by the Newman method with the Schmidt graphical method.



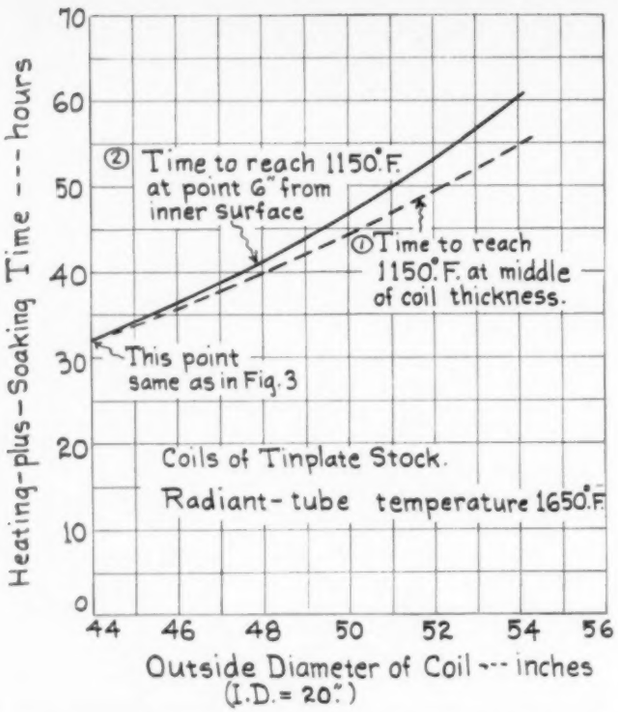
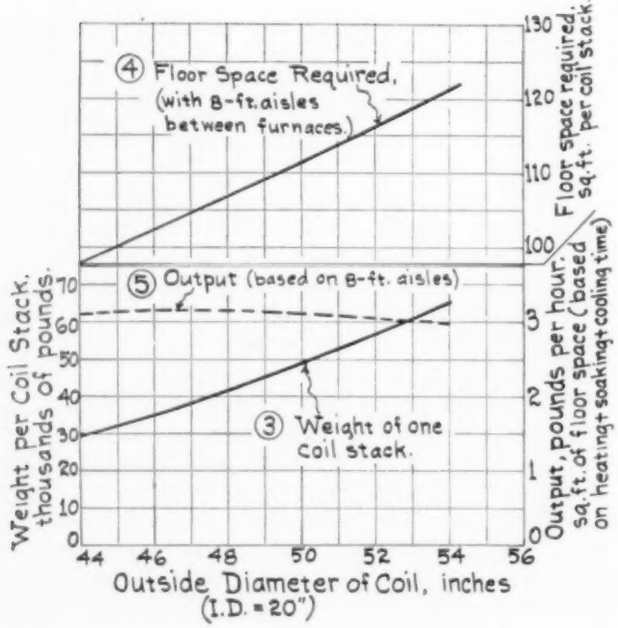


Figure 10 — The increase in heating plus soaking time as the outside diameter of the coil increases is given by this graph.

per hr per degree F for coils of 44 in. outside diameter, piled three-high, and 1.46 for coils of 54 in. outside diameter, piled four-high; the heat transfer coefficients for the ends having been taken as inversely proportional to the diameter.

Once the heating items have been determined for various coil diameters, the output can be calculated. In Figure 11 are shown the weight per coil stack, curve (3), and the floor space required by the annealing equipment, curve (4). The cooling time is usually twice the heating plus soaking time, or the total time of the cycle is three times the heating plus soaking time. Dividing the weight, curve (3), by the product (3 x heating plus soaking time x floor space) gives the output, in pounds per hour per sq ft of floor space, curve (5). The latter is found to have its maximum at about 48 in. outside diameter of coils. The floor space curve (4) was based on the assumption of 8-ft aisles between the annealing covers; if the aisles are wider, the maximum of curve (5) is shifted somewhat toward the right, but in any case, as the coils are increased to 54 in. diameter, the output definitely falls below the maximum (for equally good annealing). In the attempt to obtain increased output by using larger and larger coils, the point of best returns has already been passed, in present practice.

Figure 11 — The effect of coil diameters on weight, floor space, and output is given by this diagram. Note that output starts to decline when the coil diameter exceeds 48 in.



It was apparently the realization of this fact that led to the development of the convector spacers, with powerful fans to circulate the atmosphere gas through them, which have received considerable acceptance within the last two years. The convector spacers are placed between the coils in each stack, and they transmit heat to the coil ends. Test data show that when properly applied, such fans and convectors decrease the required heating and cooling time by at least a third, and correspondingly increase the output at least 50 per cent. Some plants report much less gain, but in general the convector spacers do unquestionably represent a very considerable improvement. By their use, the resistance to heat transmission within the coil is much reduced. However, the "bottleneck" then is likely to be shifted to the heat transfer to and from the circulated gas.

The facts that coil diameters have already been increased well beyond the optimum point as regards output; that the piling height is approaching the limit fixed by crane lift, while the weight of annealing covers (equal in size to a small house) approaches the economical limit of crane capacity; and that the gain by convector spacers is limited by the round-about method of transferring heat; all seem to indicate that the time is near when a complete revolution in annealing practice will be called for.

Once the possibility of a radical departure from present practice is conceded, many possible lines of development present themselves, and it is as yet by no means clear, which of these is likely to prove the best. One possibility already mentioned is that of handling the coils just as at present, but forcing either hydrogen or perhaps helium through the crevices between the wraps or layers; by this means, it should be possible to reduce the heating and cooling time to not over 45 per cent of that required at present for 44 in. outside diameter coils. The output would then be about 2¼ times the present figure, and would be the greater in proportion, the larger the coil. Granting that a soaking period (probably 2 to 4 hours, independent of the coil size) is desirable or necessary from the metallurgical standpoint, of optimum output would then be shifted to the larger coil diameters.

Another possibility is that of developing the heat directly within hollow spacers between the coils. Doing

this by combustion, although possible, is admittedly difficult, but heating by electrical resistors within the spacers is quite feasible, requiring only the suitable design of conductors, insulators and connections. It must never be forgotten, however, that cooling must be effected as well as heating, and has hitherto required two-thirds of the total time. The electric elements are of no help so far as cooling is concerned, but the hollow spacers could be made with separate compartments for heating and for cooling. For the latter, controlled water-spray injection could be used, (the cooling compartment forming a sort of "flash boiler"), thereby effecting not only rapid cooling but presenting the possibility of saving heat in the form of steam. Careful engineering design would, of course, be required.

Still another possibility would consist in passing the coils continuously, with their axes horizontal, through a tunnel furnace having a protective gas atmosphere. Since sticking-together of the wraps, or marking of the strip surfaces must be guarded against, the coils would have to be mounted on mandrels, with large-diameter flanges, something like the reels used for telephone cable but made of heat-resisting alloy and designed for both lightness and strength. The coils would be "pilgered" through the furnace, that is, rolled or rocked back and forth continually but with a net advancing movement. Heat would be transmitted directly from radiant surfaces in the furnace to the ends of the coil. Admittedly there would be a handling problem, but this could doubtless be solved.

From careful study of these and many other possibilities, there will doubtless emerge the pattern of annealing practice as it will be some years hence.

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DISCUSSION

PRESENTED BY

A. J. FISHER, Assistant Chief Engineer, Construction, Bethlehem Steel Company, Bethlehem, Pennsylvania

H. V. FLAGG, Combustion Engineer, Armco Steel Corporation, Middletown, Ohio

NORMAN B. JONES, Section Engineer, Industrial Heating, General Electric Company, Schenectady, New York

HARRY H. ARMSTRONG, Lee Wilson Engineering Company, Cleveland, Ohio

J. W. PERCY, Research Department, U. S. Steel Corporation, Kearny, New Jersey

J. D. KELLER, Associated Engineers, Pittsburgh, Pennsylvania

A. J. Fisher: From a personal standpoint I am in agreement with the determination of the 48 inch diameter coil as being the most economic diameter to anneal, and in addition to that, I am sure that the higher percentages of hydrogen are also in the direction of greater tonnage per hour. I am talking now about an atmosphere gas of 15 per cent hydrogen. This atmosphere is first entered into the furnace when the furnace temperature is above the ignition point of the gas, say 1000 F. This is the general practice at Sparrows Point now.

There was one question I would like to ask Mr. Keller. Consider the sun as a radiating body in which space is unlimited and in which the heat flows out without any resistance. The emissivity of the sun might be considered to be low. Then if you could install an envelope around the sun, say at the orbit of Pluto, the emissivity of the sun would be increased. Then again if you would shrink the envelope down to the orbit of Venus, the emissivity would still be increased. Again shrink it down to the diameter of the sun itself the emissivity would approach one.

Now, that is just about what you have in that coil. You have two surfaces close together. My question to Mr. Keller: The closer that you get the surfaces together, does not the emissivity of the two surfaces, irrespective of what they are, cancel out and become very close to one?

H. V. Flagg: Mr. Keller's paper has certainly been very interesting in developing a different approach to a very complicated system of heat transfer. I might say that our own experience has been entirely with sheet coils, so that my comment will be concerned entirely with sheet coil annealing, whereas Mr. Keller's paper deals almost entirely with tin plate annealing. The two processes are quite different. In his paper he mentioned casually the difference between heat transfer through sheet coils as compared to tin plate coils, but I question whether he has emphasized the difference quite enough. We know that the characteristics of the green coils and the heat treatment required of the two products is entirely different.

He makes the statement in his paper that the usual practice of heating coils and the type of equipment employed is dictated more by a question of convenience in handling than by any other consideration. I might say that we have been cognizant of the advantages to be gained by heating coils from the ends rather than from the sides for at least ten years, and have made several experiments which have established the benefits to be gained. The reason more progress has not been made has been a matter of practical development rather than desirability. We have not been able to find any practical method of heating coils from the ends until quite recently. Recent developments have provided some approach to the problem but in that development have come problems not even the builders appreciated until they began actually to build the furnace.

Mr. Keller's analysis of the three factors that influence the heat transfer through the multiple wraps of the coils was interesting, particularly since it brought out the unimportance of radiation and the metallic contact factor, and emphasized the importance of the con-

duction through the film. The significance of these heat transfer influences is not well understood.

His suggestion that hydrogen be used for protective atmosphere raises the question already discussed of cost and safety hazard. I do not think any of us would question the desirability of hydrogen for this purpose but the problem would be one of expediency and cost.

He mentioned the increase in heat transfer to be gained from fans under the coil base. This again raises the question of whether it is tin plate or sheet coil that is being annealed. On tin plate coil annealing, the benefits of fans have been well established; on sheet coils probably not so conclusively.

On his suggestion that we make a continuous furnace for annealing coils, I can foresee a good many difficulties in its way. The engineering problems involved in constructing a conveyor which would carry the heavy loads at sustained high temperature with semi-continuous rotation of coils would be enormous, and maintenance costs on such a conveyor might well be prohibitive.

Norman B. Jones: When Mr. Keller mentioned a continuous furnace it brought to mind a proposition I worked up some years ago for a non-ferrous mill for annealing of coils continuously which died a natural death as about 90 per cent of our propositions do during peacetime. We were going to do about the same as Mr. Keller was suggesting, carrying the coils with the edges exposed, only we were not going to roll them. We were going to mount them on mandrels supported from cantilever rolls, projecting in from each side of a roller hearth furnace. The ends of the mandrels were to rest on the saddles and these saddles were to be carried along by the rolls and also carry the coils through the furnace. Now, no doubt there are some practical reasons why that would not work with steel coils and perhaps it would not have worked with aluminum, which this happened to be.

Harry H. Armstrong: The bulk of the work which enabled Mr. Keller to write his informative paper was done at a time when the trade was requesting annealing data on steel strip coils as large as 78 inches in diameter.

At that time facilities for coiling and heating anything over 54 inch diameter were not available. Consequently, it was impossible to do the conventional, which is to run an actual test and determine the heating characteristics of the coil sizes in question. Instead, from existing data it was necessary to make a careful study of the various mechanisms by which heat is transferred in coils and to determine the relative values of each. From these values, formulae were developed from which the heating times of any sized coil can be determined.

As his paper attests, Mr. Keller was a happy choice to make this investigation. His findings, which indicated that the heating time in a conventional furnace varied roughly as the square of the coil radial thickness, were a matter of much concern. This concern was not with the required increase in floor space per ton of material annealed, because this could be overcome by the compensating advantage of large coils elsewhere in their production. Rather, the concern was for the quality of annealing, or, specifically, that the time temperature uniformity be equal or, preferably, better than that which sufficed in smaller coils.

The calculations indicated otherwise, specifically that the outer wraps of the large coils might be at temperature as many as one hundred hours before the inner wraps could reach even the minimum demanded. This is exactly the condition that causes variation in grain size as regards structure and causes sticking as regards surface conditions.

For apparent reasons, the use of a protective atmosphere, largely hydrogen, as suggested by Mr. Keller for reducing furnace time, could not be considered. The only alternative was to seriously review the possibilities of heat application to the coil ends, which offers a metallic path to the least accessible parts of the coils. The results of these studies is the radiant tube convector type furnace which Mr. Keller referred to.

With this equipment much smaller variations in time temperature field have been obtained with the largest coils annealed to date than was ever possible in the older conventional type furnace. Fortunately, this condition is achieved without loss in production rates. In fact, vastly increased production per square foot of floor space is a valuable by-product.

As an example of temperature uniformity with time, a charge of 54 inch diameter sheets will have a bottom coil edge temperature of 1300 F about six hours after the top coil outside wrap has reached 1400 F. As an example of production rate, a four-stack furnace of 60 inch diameter tin plate coils, stacked four high, will reach a satisfactory temperature field in such a period that a furnace rate will be from 6 to 7½ tons an hour. The cooling rates in this equipment are likewise increased in the same proportion as is the heating rate so that in most cases an average of 2½ bases per furnace is sufficient.

As to further advances in annealing practices, we quite agree with Mr. Keller that they will probably be of a radical nature. As an instance, we are at this time investigating in our laboratory an annealing method that is far more radical than anything outlined in Mr. Keller's paper.

J. W. Percy: It appears to me that Mr. Keller has lacked adequate information upon which to base his calculation. It is true that comparatively little such data have been published, but much of it is in existance. As far as actual temperature measurement upon heat transfer through coils of strip is concerned, the job is not difficult and many such tests have been made. In such exploratory tests it is desirable that as many as thirty or forty thermocouples be located at strategic points in the stacks of coils.

Mr. Keller seemed to lack data on tension in the coil or pressure between wraps. As each coil is run on to the reeler, the tension is observed continuously. It is true this is usually observed as current (amperes) but it should not be too difficult to translate these data into tension and then into pressure. I believe he may find the pressure between wraps somewhat higher than the ten pounds per square inch he indicates in his paper. If such proves to be the case, I should like to point out that the film thickness between wraps may be approaching the mean free path of the gas at which point the laws of conductivity no longer hold but the heat transfer reaches a constant minimum.

Mr. Keller certainly introduced some very interesting angles to an old problem, and his presentation was excellent. It seems to me, however, I rather agree with Mr. Flagg that he did a lot of work for which he can expect comparatively small returns. Such calculations are long and tedious; to me it seems so much simpler to measure them. He is concerned with the heat transfer through a coil and it is no trick at all to place a number of thermocouples in a coil or coils and make very accurate measurements of the heat transfer, through the coil, under any condition one cares to establish.

J. D. Keller: I am very glad that this paper has aroused so much discussion, which is what was hoped for. Even the adverse criticism indicates interest in the subject and in the paper.

Now, taking up the various points in the order in which they were brought up, Mr. Fisher asked about a possible increase of emissivity when the radiation-emitting and radiation-absorbing surfaces are close together. His idea is that the radiant-heat transmission in such a case approaches that of ideal black-body surfaces, even if the emissivity of each surface is quite low. While this idea seems to be rather widely held, it is incorrect. Both experimental work radiation theory show that even in such a case the emissivities of the surfaces are still of importance. If p_1 is the emissivity of one of the surfaces having area A_1, and p_2 that of the other surface of area A_2, the overall emissivity factor (8) * lies between the values

$$\frac{1}{1/P_1+1/P_2-1} \text{ and } \frac{1}{1/P_1+\frac{A_1}{A_2}(1/P_2-1)},$$

and if the areas are equal, these both reduce to the left-hand expression. For the surfaces of cold-reduced steel strip, having $p_1 = p_2 = 0.216$, the overall factor becomes 12.1 per cent of the black body radiation. But even if the surfaces were so oxidized that their emissivities were practically equal to the black-body, radiation even then could account for only 1 per cent of the total radial heat transfer within tin plate coils, and 3½ per cent in coils of auto body stock.

I am glad to have Mr. Fisher's confirmation, from actual trials, that the optimum coil diameter is about 48 inches; although, to be sure, the curve (5) in Figure 11 is quite flat-topped and a reasonable variation either way, in the diameter, would not make too much difference.

Now, referring to Mr. Flagg's discussion, it is of course true that there is a difference of practice between annealing of coils for sheets and annealing of coils for tin plate. Because of the different ductility and other properties desired, the whole temperature level is higher for sheet coil annealing than for the tin plate coils, while there is the same upper limit of allowable radiant tube temperature in both cases. But so far as the conductivities and other thermal properties are concerned, apparently there will not be much difference. As mentioned in the paper, the radiation transfer within the sheet coil would be about 3½ times as high, because of fewer radiation jumps, but still the radiation would amount to only about ½ per cent of the total. So far as the contact conductance is concerned, that would be somewhat higher because of the greater pressure between the wraps; nevertheless, the gas-film conductance accounts for by far the largest, in fact almost the only important part of the total heat transfer just as in tin plate coils. Unfortunately, I did not have reliable test data for sheet coils in the form of temperature vs time curves which could have been analyzed in the same way as for tin plate coils, but known values of the total heating time in sheet coil annealing practice indicate that the radial conductivity and diffusivity cannot differ very much from the values for tin plate coils.

Again referring to Mr. Flagg's discussion, it was by no means my intention to belittle the handling problem, which undeniably is extremely important, but only to point out that in concentrating on it, the primary requirement for annealing, namely, heat trasmission, was in danger of being overlooked.

Mons parturibat . . . at ille murem peperit, (the mountain labored and brought forth a mouse) in effect say Messrs. Flagg and Percy. If the object of the paper were taken to be merely to prove the statements made in the (perhaps superfluous) introductory paragraphs, this might be a fair evaluation. But there is much more to the paper than that; any one reading beyond the first few paragraphs will find information and methods developed that will be applicable not only to present practice (which apparently is about to be superseded) but also to any conceivable future development in the annealing of coils. As to the inference that the facts brought out in the paper were already well known, I must sharply disagree; while the paper was being prepared, I discussed heat transmission in coil annealing with not merely a few but a number of engineers and research men, all interested in and familiar with the matter, and found, for example, that not one of them, literally not even one, had any inkling of the fact that gas-film conduction is the controlling factor in the heating and cooling of coils. In my opinion, scientific analysis such as exemplified in the paper, and even more intensive, will have to be applied more and more to the problems of the steel industry if progress is to continue.

From Mr. Jones' discussion, it is interesting to learn that his firm had proposed a method of handling coils during heating which is akin to what I called "pilgering" the coil through the furnace.

As to Mr. Armstrong's discussion, in order to set the record straight, I wish to say that only a comparatively small part of the analysis and development presented in this paper was completed in the course of the work for Mr. Armstrong's firm; the greater part of it is entirely new, having been developed by me independently at a later time. In the work done for Mr. Armstrong's firm about three years ago, I did not then have the time available nor did they wish to go into the matter to the full extent. The work was carried far enough to obtain an approximate relation between coil diameter and heating time, but nothing was done on contact resistance or on the later methods of taking care of the combined effects of radial and axial conduction, nor was the optimum coil diameter determined. All of these were developed in my own later work.

(8) * H. C. Hottel, *Mechanical Engineering*, vol 52 (July, 1930), page 700; also O. A. Saunders, Proceedings, Physical Society (1929), vol 41, page 569.

It is a pleasure to learn that, for a change, my suggestions are considered not radical enough, and I look forward with great interest to the unveiling of the annealing method which Mr. Armstrong states will be of a really radical nature.

Referring again to Mr. Percy's discussion, none of the information presented in the paper was "picked out of the air," as Mr. Percy seemed to think; every item was carefully checked with actual operating data. Figure 5, showing the cross-sectional shape of cold-reduced strip, to which Mr. Percy took strong exception in the oral discussion, represents the actual measured cross-section found in the average rolling practice of one of the very large producers of cold-reduced strip. The illustration is, to be sure, somewhat idealized; the peculiar irregularity near the edges which results from lateral spreading in the rolls of the mill has not been shown; also, the actual contour does not have exactly the straight-line taper shown, although it is nearer to that than to the curved contour which might be expected. I do not say that every strip from every mill has exactly this cross-section; nevertheless there is no use deceiving ourselves into thinking that any strip is perfectly flat; marvelous as is the modern strip mill, it is not as perfect as all that.

Mr. Percy is of the opinion that the radial pressure is more likely to be about 30 psi than the 10 psi stated in the paper. It was indeed difficult to obtain definite information as to the coiling tension; I inquired of the makers of coilers, and also of well-known steel manufacturing firms, and no one knew. If the information is as well known as Mr. Percy says, it is too bad it has not been published. In any case, it is difficult to see how an average radial pressure as high as 30 psi could be produced unless the coiling tension exceeded the elastic limit of the strip material (in the case of tin plate coils); but even if it were 30 psi, according to Holm [1] the true contact-conductance varies about as the $^9/_{10}$ power of the pressure, hence it would be about 1.92 times as great as for 10 psi. The contact conductance might then amount to nearly 4 per cent of the total, but almost 96 per cent would still be controlled by the gas-film conductance.

The one really important point brought out in Mr. Percy's discussion has to do with the limitation of the amount of heat conducted through the gas film when the film thickness is equal to or less than the mean free path of the gas molecules, according to the kinetic theory of gases. It should have been stated in the paper that this effect had not been forgotten. The mean free path, for air or similar gases, at room temperature is about 2½ micro-inches, and as the height of the peaks in the strip surface is believed to be about 120 micro-inches (Figure 6-d), and minimum gas-film thickness is evidently far above the limiting value. Only in the case of the idealized contact shapes of Figure 6-a and 6-b would the limiting thickness be reached near the points of contact, resulting in a moderate reduction of the form-factor multipliers for those shapes.

If Mr. Percy's test data consisting of time-temperature curves from thirty to forty thermocouples placed at various points within the wraps of piled coils during annealing is available, it is suggested that he publish them in the interest of science, either with or without an analysis such as given in this paper.

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DESCALING OF STAINLESS STEEL

. . . . economical descaling of stainless, once a difficult and uneconomical process, can now be done by two types of caustic salt bath treatments . . . .

SODIUM HYDRIDE Ddescaling OF STAINLESS AND CLAD STEELS

By JOHN S. MORRIS, Special Engineer
Lukens Steel Company
Coatesville, Pennsylvania

▲ IN line with its policy of producing quality products Lukens Steel Company completed in 1947 the installation of a soduim hydride descaling plant for the removal of metallic oxide scale.

One of the major problems faced by a producer of stainless steel or stainless-clad steel products is the removal of the oxide scale formed during the heating, or heat treating processes. Various means have been used in the past to remove this scale, such as sand or grit blasting followed by pickling in two or more acids, or a longer pickling cycle without the aid of blasting prior to pickling.

Neither of these methods have proved entirely satisfactory either from cost or production viewpoints. Blast cleaning is a laborious method of removing the scale and involves health hazards. In addition, it is unsatisfactory since it peens over minor surface flaws so that they are not immediately visible. The long-pickling cycle is costly since pickling loss of good metal amounts to 2 to 3 per cent or more of the weight. Where large tonnages of high-priced stainless steel products are pickled, this loss in weight will amount to a sizable sum over a period of time.

Several new methods of removing scale have been developed. Installations of two of these methods will be described in this and the following paper. This particular paper will discuss a sodium hydride descaling installation.

Numerous papers have been written describing the processes in detail, so a minute description here is not necessary. Briefly, the new processes consist of immersing materials to be descaled in a molten caustic bath impregnated with sodium hydride. The caustic bath provides the necessary wetting action and carrying body for the sodium hydride which has a great affinity for the oxide scale. Any scaled material thus immersed in the bath has its scale reduced to elemental iron which remains on the material in forms ranging from finely divided powder to large foil-like patches. The time cycle for the scale reduction will vary depending upon the material, from 5 to 20 minutes.

Presented before AISE Philadelphia District Section Meeting, February 7, 1948

Upon completion of the cycle of immersion in the 700-725 F sodium hydride bath, the hot plates are dipped into a water quench tank. The violent reaction created by the formation of steam and explosive reaction of sodium hydride and water, literally blasts the plate clean of its coating of reduced scale.

Next, a dip in 10 per cent sulphuric acid is necessary to neutralize any caustic remaining on the work as it emerges from the quench tank. Time of dip approximates 3 minutes.

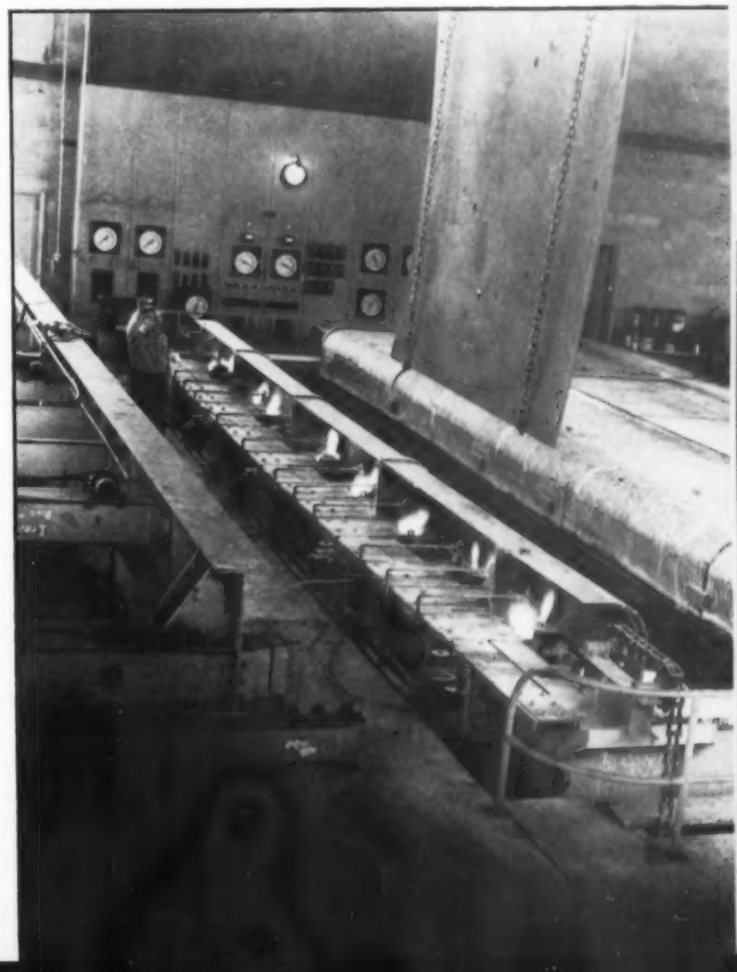
The material is then dipped into a nitric-hydrofluoric acid bath for brightening purposes. Time of this dip approximates 6 minutes.

Emerging from the nitric-hydrofluoric acid bath the material is then spray-cleaned with water either from a hose or in a high pressure spray tank as the case warrants.

HISTORICAL DATA

Approximately seven years ago, Dr. Harvey N. Gil-

Figure 1 — The excess hydrogen is burned to eliminate possibilities of explosion.



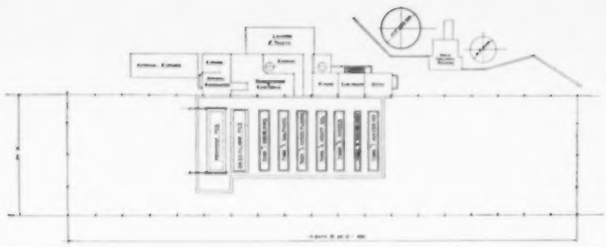


Figure 2 — The new Lukens' sodium hydride plant is the world's largest such installation.

bert started laboratory experiments using metallic sodium to reduce the scale since sodium was known to be a good reducing agent. Difficulties were encountered in uniformly wetting the scale with the sodium. When a reaction did occur, the reduction was accompanied by the formation of corrosive sodium oxide. This, and other operating difficulties caused this method to be abandoned.

Next, a bath of fused caustic containing molten sodium was tried but found to be impracticable because of its corrosive qualities and large accumulations of sludge.

Further experimental work demonstrated that sodium hydride, dissolved in fused caustic, readily reduced the oxide to metallic or elemental iron. The sodium hydride in reacting with the scale formed caustic soda which was the material comprising the carrier bath.

Since sodium hydride, as such, was not commercially available at that time, further experimenting led to the method of maintaining a sodium hydride bath that is in use today.

MAINTAINING A SODIUM HYDRIDE BATH

Anhydrous ammonia and metallic sodium are the two materials now used to form sodium hydride in the molten caustic bath. The ammonia is passed through dissociators to form a dissociated gas consisting of 75 per cent hydrogen and 25 per cent nitrogen. Sodium and hydrogen react directly to form sodium hydride as shown by the following equation:

$$2\,Na + H_2 = 2\,NaH$$

Generator boxes are suspended along one side of the molten caustic tank. The bottoms (which are open) of these boxes are submerged to a depth of approximately 18 in. below the surface of the bath. Metallic sodium is then placed in each generator box and hydrogen from the dissociators is bubbled up through the molten caustic in each generator box. The intimate contact between the sodium and hydrogen in the generator box speeds the reaction and formation of sodium hydride which disperses itself evenly throughout the bath.

Figure 3 — A regular mill type building is used to enclose the sodium hydride plant.

Figure 4 — Indicated on this cut are the steps in the sodium hydride treatment. The sequence order starts with the furnace shown in the upper left hand portion of the photograph and ends with the hot water rinse in the right hand portion of the photograph.

Vent holes in the top of the generator boxes allow excess hydrogen to escape. In order to prevent a critical mixture of air and hydrogen in the portion of the generator boxes protruding above the level of the liquid molten caustic, more hydrogen is fed into the generator boxes than is necessary for the reaction with the sodium. This excess hydrogen passes out the vents and is burned as a soft yellow flame as shown in Figure 1.

The sodium hydride content of the bath is maintained at from 1.5 to 2.0 per cent by regulating the amount of sodium and hydrogen charged into the generator boxes.

As work is processed through the sodium hydride bath, its sodium hydride content is reduced as the scale is reduced. The chemical reaction with scale is as follows:

$$4\,NaH + Fe_3O_4 = 3\,Fe + 4\,Na\,OH$$

To maintain the proper sodium hydride content, the bath must be checked every hour. This check is made by ladling a 2-gram sample into a small split mold. This sample is then placed in a gas evolution apparatus which quantitatively measures the hydrogen evolved when the sample is dissolved in water. The apparatus is so graduated that the percentage of hydride content may be read directly on the bell collector.

LUKENS' SODIUM HYDRIDE PLANT

The use of sodium hydride as a descaling method was retarded somewhat during the war years due to the scarcity of metallic sodium which was numbered among the many important strategic materials. Its use in the steel industry gained momentum after the war and at present the consumption of metallic sodium is up to the quotas available from manufacturers. Lukens Steel Company's installation is one of the most recently completed plants.

The installation at Lukens Steel Company is unique, since in keeping with its slogan of "The World's Largest

Plate Mill," it was necessary to make an installation in which these long, wide, and thick plates could be processed; therefore, we can now say we have "the world's largest sodium hydride installation."

A thorough study of sodium hydride plants in operation was made by the engineers prior to the preliminary planning. Operators in other plants were most cooperative in giving information as to where improvements in existing installations could be made. With this information in hand and with some original ideas of our own the following plant was built.

Figure 2 is a plan view of the new plant showing the relative location of the equipment with respect to the building.

Sodium hydride pickling building—Since the old pickling plant at Lukens was out in the open and serviced by a gantry crane, the erection of a new pickling building was necessary to house the sodium hydride descaling equipment. A new steel building 380 ft long x 86 ft center to center of columns was erected to house the new installation. Figure 3 is a picture of the new building. To eliminate the possibility of "corrosive pockets" being formed where the fabricated members came together, all-welded construction was used throughout.

After completion of the erection, the steel work was coated with a special acid-resistant paint. This paint was sprayed on in one coat and is $\frac{1}{16}$ to $\frac{3}{32}$ in. thick. As an added precaution, bolts and nuts, used to fasten the protected roofing and siding, and the steel sash were painted with this special acid-proof paint.

Lighting—Two rows of window sash, each 7 ft $1\frac{1}{2}$ in. high, are on both sides of the building, the bottom row of sash being 12 ft 6 in. above the floor level. Likewise both ends of the building have two rows of sash in them, the lower row being 21 ft 6 in. above the floor level. These windows admit plenty of light during daylight hours.

At night, the building is lighted electrically by a combination of incandescent and mercury vapor lights. A row of 3000-watt mercury vapor lights and 1000-watt incandescent lights alternately spaced on 20 ft centers is in the center of the building. On either side of this center row there is a row of incandescent lights spaced on 20 ft centers. Incandescent lights with built-in reflectors were used because they assure maximum lighting throughout the life of the bulb, and no cleaning of exterior reflectors is necessary.

This combination lighting supplies approximately 18.6 ft candles of illumination at floor level.

Crane service—Crane service is supplied by two ten-ton, two-trolley bridge-type cranes having a span of 84 ft $11\frac{1}{2}$ in. Each crane has one five- and one ten-ton trolley.

Service building—A service building adjacent to and extending 140 ft on the north side of the main building furnishes the space required for office, maintenance shops, acid and sodium storage, electrical control room, ammonia dissociator room, and locker rooms. The walls of the service building are of concrete block.

Railroad and truck doors are located in either end of the building.

Ventilation—The building is ventilated by six 60 in. diameter motor driven ventilators located in the apex of the roof. Each ventilator is driven by a 10-horse power motor and is capable of exhausting 36,000 cfm. The combined exhaust capacity is 216,000 cfm.

One ventilator is located in the third bay from either end of the building. The other four are concentrated in the section immediately above the descaling tanks. This area over the tanks is baffled off from either end of the building by a partition down to the lower chord of the roof truss. This baffle tends to keep any fumes which rise to the roof concentrated in the pickling section and away from the receiving and shipping area.

Outlets for welding machine, high-cycle grinders, and compressed air are conveniently located along the north wall.

Sodium hydride descaling equipment—In the sequence of use, the equipment comprising Lukens' installation is as follows: preheat furnace, soduim hydride furnace, quench tank, sulphuric acid tank, nitric-hydrofluoric acid tank, krupp mixture of acids (not used in sodium hydride descaling), water holding tank, spray cleaning tank, and hot water rinse or coating tank. The entire group in the sequence named above is shown in Figure 4. This equipment with the necessary acces-

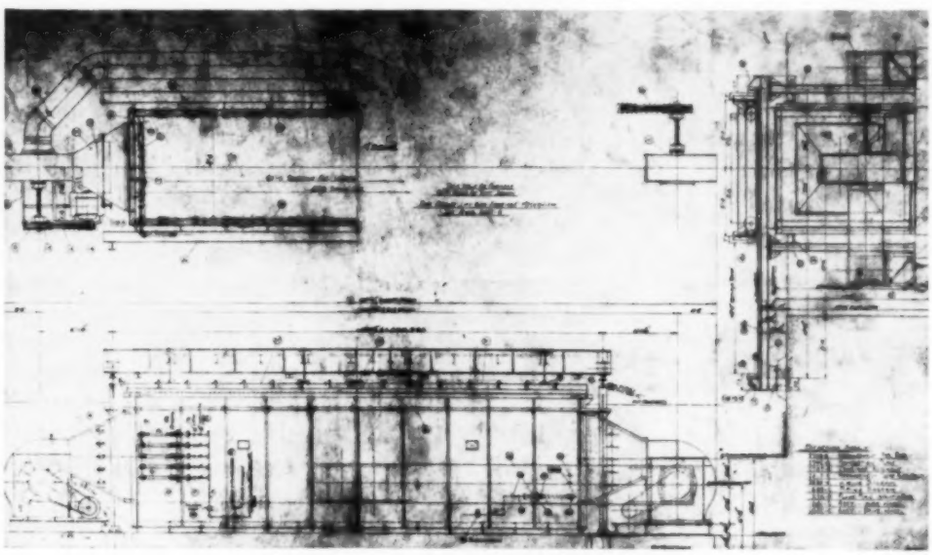


Figure 5 — General arrangement of preheat furnace.

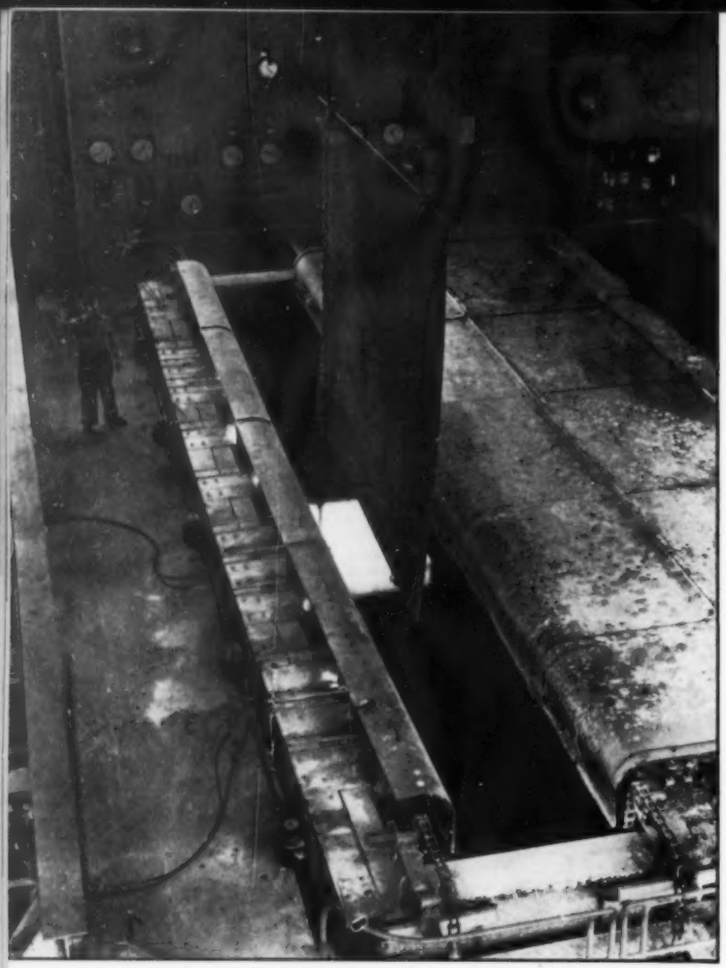


Figure 6 — The pot has a capacity of 147 tons of molten caustic at its normal operating depth.

sories comprises the sodium hydride descaling unit. One of the features of the installation is that with the exception of the tanks and furnaces, all equipment is below the floor or in the adjacent service building. The pit in which the equipment is set is 136 ft long x 72 ft wide x 13 ft 6 in. deep.

Preheat furnace—Upon studying various other sodium hydride descaling installations and talking to the operators thereof, it was decided that the cycle of operations was dependent upon the length of time the charge or rack of plates had to be held in the sodium hydride bath. It was known that upon immersing a charge of cold plates in the molten caustic bath, a thin coating of caustic would freeze immediately on the plates or bars; and until the plates were in the bath long enough to absorb sufficient temperature to remelt this solidified layer of caustic, the decomposition of the scale by the sodium hydride could not begin. Therefore, a decision was made to incorporate a preheating furnace in the Lukens installation. To avoid possible delays the preheat furnace was designed to hold two racks of plates at a time, and was to be capable of maintaining a temperature of 700 F.

The preheat furnace finally decided upon was designed to heat 30,000 lb of ¼ in. thick steel per hour from 70 F to 700 F, using natural gas as a fuel, and recirculating the heated air over and through a pattern of line flame burners.

This preheat furnace has the following dimensions: Inside chamber: 9 ft 6 in. wide x 42 ft 0 in. long x 12 ft 0 in. deep. Overall: 31 ft 1½ in. wide x 67 ft 7¼ in. long x 17 ft 2¼ in. high. Figure 5 shows a general arrangement of this furnace.

Construction—The construction of the furnace is unique in that no brick are used—the inner and outer chambers are of steel with mineral wool packed between them.

The outer shell is fabricated from ¼ in. thick steel plates substantially reinforced with structural shapes to form a rigid chamber. The inside or working chamber is constructed of ⅜ in. thick steel plates and structural guide members. The space between these two shells is insulated with 6 in. of mineral wool. The design of the inner shell is such that it can expand and contract with temperature changes with little or no stress on the outer shell. These expansion joints are protected by inverted channel guide members.

A formed steel plate around the top periphery of the furnace serves to cap the inner and outer shells and also forms the "gutter" for the sand-seal between furnace and cover.

The cover of the furnace is fabricated from steel plates and structural members and likewise is insulated with mineral wool. It is arranged to seal on all four sides into a deep sand seal. When charging the furnace, the cover is lifted out of the sand seal by a motorized hoist mounted on a motorized bridge on four wheels, and supported by rails at either end of the furnace. This bridge supporting the cover is then traversed to the side of the furnace, similar to a soaking pit having a cover crane. The cover is automatic in its operation of raising, traversing, and lowering and is controlled by means of a push-button station marked "Open" and "Close." This push-button station is located on the building wall away from the furnace.

The recirculating air duct outlets are in the center of the furnace, one on either side, 6 in. above the bottom of

Figure 7 — Welded construction was used in fabricating the pot which was set on a foundation of insulating brick.

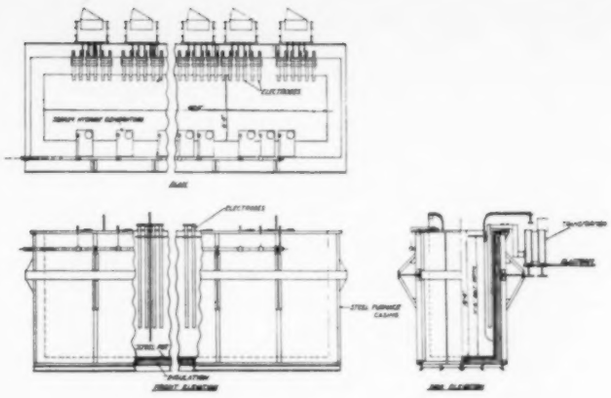


Figure 8 — The descaling furnace is rated at 800 kw.

the inner chamber. These ducts are rectangular (3 ft 3 in. x 2 ft 6 in.) and are made of $\frac{3}{16}$ in. thick steel plate. Expansion joints are provided at either end. The ducts are insulated with 2 in. of standard block insulation and $\frac{1}{2}$ in. of insulating cement. The casing of the fans at either end of the furnace into which the recirculating duct enters, is likewise insulated with 2 in. block and $\frac{1}{2}$ in. cement.

Heating—The furnace is heated by a pattern of line flame burners located at either end of the furnace, which are supplied with natural gas through mixers which inspirate sufficient air for combustion.

High temperature (1200 F) centrifugal fans (38,000 cfm capacity) located at either end of the furnace draw the hot air out of the furnace through the recirculating ducts and pass it through the pattern of line flame burners to be reheated. This recirculation of the hot air from the ends of the furnace to the center assures an even temperature in the furnace and aids in the transfer of heat to the plates.

Electronic recording control instruments which automatically throttle the fuel flow, control the temperature of the preheated air as it leaves the patterned flame burners, at either end of the furnace. Each end of the furnace has a pilot light for the patterned burners and this pilot light is protected with units which automatically shut off the entire fuel supply, in case of pilot light failure. The pilot lights are automatically lighted by push-button ignition. In case of pilot light failure, a horn continues to blow until the operator shuts it off and relights the pilot. This double safety feature prevents any possibility of hazardous conditions in the furnace.

This furnace has proved satisfactory in every way, maintaining a very uniform temperature. It has been pushed beyond the 700 F temperature for which it was designed, maintaining an 800 F temperature satisfactorily, without any apparent damage to the steel lining of the inner shell.

Sodium hydride furnace—Three methods are in general use for heating pots containing molten caustic, namely: external firing with gas or oil as fuel; internal firing with immersion heating tubes using gas as fuel; and electrical induction heating. For Lukens installation, induction heating was selected, because the depth

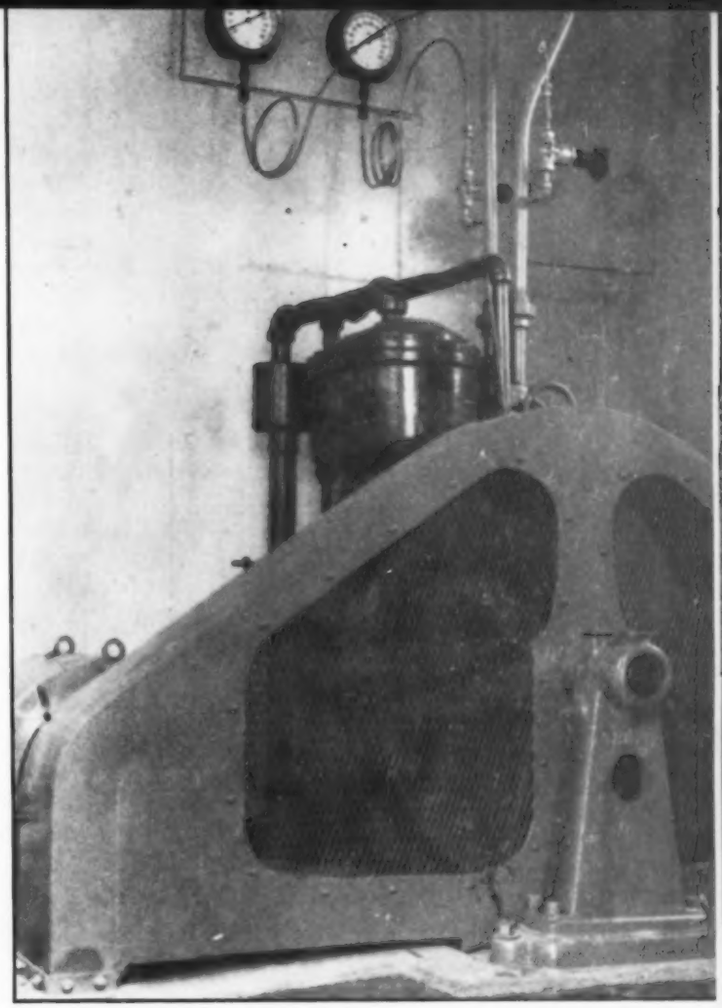


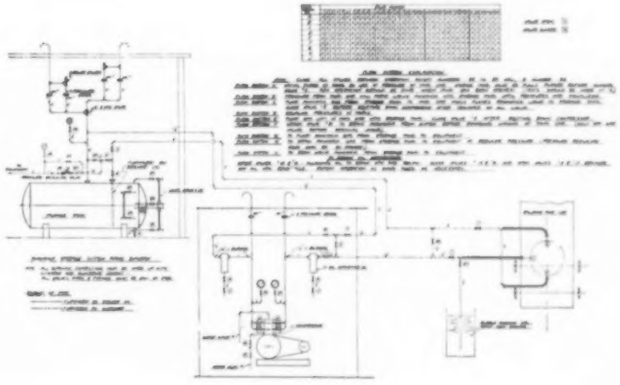
Figure 9 — A vertical two cylinder ammonia compressor with a four way valve manifold is used to unload the ammonia.

of the bath was so great that some form of agitation would be required. The electrical heating units furnish a certain amount of agitation in the bath due to the convection currents between the electrodes.

Following the decision on the method of heating, the manufacturer of the furnace was called in to consult with the engineers as to size requirements. This consultation resulted in the design of the world's largest molten caustic sodium hydride bath.

Figure 6 shows a view of the furnace in operation.

Figure 10 — Schematic diagram of the ammonia storage system.



The pot has a capacity of 147 tons of molten caustic at the normal operating depth of 11 ft-6 in. It is 40 ft-0 in. long x 6 ft-4 in. wide (4 ft-0 in. between guards) x 12 ft-0 in. deep inside dimensions. Firebox quality plates 1½ in. thick were used in its all-welded construction. The completed pot weighed 35 tons and was shipped to the site in two sections, where it was field welded and set as a unit on the foundations.

Figure 7 shows a view of the pot after it was welded and set on the foundation of insulating brick. The vertical weld seam may be seen on the near side.

On a pot of such size some insulation and additional bracing would be required or tremendous heat losses and deformation of the pot would result. Therefore, an outer shell of fabricated steel work with insulation between was necessary. This outer shell and bracing was also necessary to support the electrodes and transformers. This steel outer shell was further braced by 27 in. wide flange beams around the furnace about 9 ft-0 in. from the bottom.

Figure 8 is a cut-away view of the furnace.

The caustic is heated by the immersed electrode principle. In this method a low-voltage, high-amperage current is passed through the electrodes and the intervening body of molten caustic. The resistance of the caustic bath to the electric current passing between the adjacent electrodes generates the necessary heat, and automatic circulation of the bath is produced by electrodynamic forces generated by the patented electrode arrangement. This furnace has a maximum power input of 800 kw distributed over 24 pairs of electrodes with a total weight of 21,550 lb.

The electrodes are 4 in. square, of a special alloy steel. They are spaced 3½ in. apart and 3 in. out from the vertical wall of the pot.

Eight, 100 kw star-connected transformers for 440 volt, 3-phase 60-cycle current are used to furnish power to the electrodes. Three sets of single-phase electrodes are connected to each transformer. For controlled heating purposes, the tank is divided into two zones, each zone measuring one-half the tank length, and four transformers. Each transformer is equipped with safety switch, contactor, push-button and current transformers, which allows any individual transformer to be shut off for maintenance purposes without affecting the operation of the furnace.

The eight transformers, like the electrodes, are located along the east side of the furnace. The transformers are supported on a steel catwalk, with the electrodes on the outer binding of the furnace. There is sufficient open space on the catwalk for easy access to the transformers to make repairs.

The electrodes, and transformers are protected from bumpings and dripping caustic when the racks are removed from the bath by heavy (1¼ in.) plates extending to the quench tank as shown in Figure 6. Similar formed plates protect the sodium generator boxes also.

The control panel is equipped with automatic recording temperature controllers, ammeter switches, ammeters, push-buttons, and pilot lights for each individual transformer.

To insure an uninterrupted source of power, a substation consisting of three 300 kva single phase 13,200 volts to 400 volt transformers was installed with necessary control and protection equipment. These transformers are air-cooled type. A 12,000 cfm fan is used to draw outside air through a filter, and force it up through the transformers. This incoming volume of air cools the transformers and also serves to pressurize the substation control room.

The 12 sodium hydride generator boxes may be seen in Figure 8. They are located on the opposite side of the furnace from the electrodes, and are bolted to the outer shell of the furnace. These boxes (open at the bottom) are approximately 20 in. long x 10 in. wide x 30 in. deep. They extend about 24 in. into the molten caustic. The hydrogen tubes extend about 18 in. into the box and are removable by unscrewing a standard pipe union. Sodium is fed into the top of the box through a 6 in. diameter hole, with a removable lid. These generator boxes are protected by a curved steel guard plate.

Agitators—Due to the depth of the bath it was believed additional agitation would be necessary. Ten motor-driven agitators were designed and installed, five per side, but to date we have been unable to find any bearing that would stand up in the molten caustic. So, at present we depend on the agitation resulting from the downward electrodynamic stirring action. Further studies as to possible methods of increasing the agitation by mechanical means are being made at present.

When not in operation the bath surface is covered by light gage metal pans floated on the surface to help diminish the hydride loss.

Anhydrous ammonia storage system—In connection with the sodium hydride bath, anhydrous ammonia is necessary as a source of hydrogen. Preliminary calculations showed that the quantity of anhydrous ammonia used in forming the necessary hydrogen would be of

Figure 11 — Two 1200-cu ft per hr dissociators of the nickel catalysis type, fully automatic, were installed to form the sodium hydride.

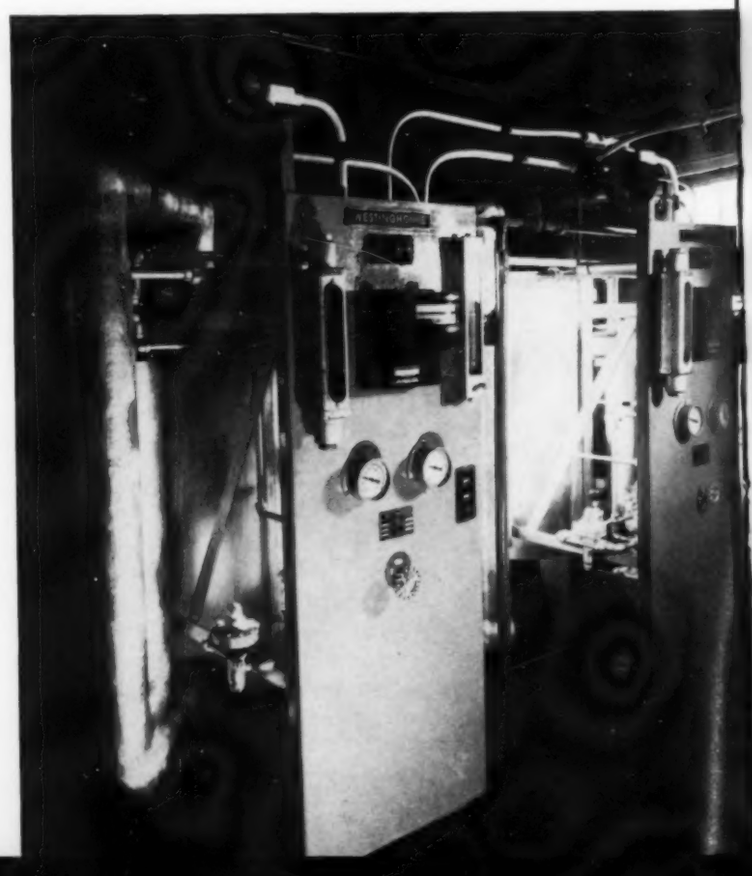


Figure 12 — The pumps for the spray cleaning tanks are located in the basement.

such magnitude that it would be more economical to purchase the ammonia in tank car (10,000 gal) lots. Also, the labor involved in replacing small containers when empty would be great, and constant checking would be required to maintain an adequate supply. Therefore, an ammonia storage system consisting of a pumping station and a 13,000-gallon storage tank was installed.

The storage tank is 7 ft-6 in. inside diameter x 40 ft-9 in. inside the heads. It is constructed of SAE-212, firebox grade, $\frac{7}{8}$ in. thick steel plates. All joints are fusion welded. A hydrostatic test of 450 psi was made before releasing the tank for service. The normal working pressures will vary from 50 psi in winter to 250 psi in summer.

The unloading compressor, (Figure 9) is a 4 x 4 in. vertical 2-cylinder ammonia compressor, with a 4-way valve manifold. City water is used for cooling the compressor since it is used only when unloading a tank car of ammonia.

Figure 10 is a schematic diagram of the piping involved in the ammonia storage system. All piping is of extra heavy steel with welded joints throughout. Threaded joints at valves are sealed with litharge and glycerine. The entire system was tested for leaks (soap bubble test) with compressed air at 110 psi before starting to unload ammonia.

In unloading a car of ammonia, two flexible hoses are attached to the outlet pipes on the tank car, these hoses leading to a 2 in. liquid line going to the storage tank. From the storage tank a $1\frac{1}{2}$ in. gas line leads into the compressor where its pressure is raised to 50 psi and forced into the tank car by the third flexible hose. The differential in pressure between the tank car and the storage tank is sufficient to force the liquid ammonia from the tank car into the storage tank. It requires about $2\frac{1}{2}$ hours to unload a 10,000-gallon tank car.

Special ammonia valves, lead-sealing gaskets, and rupture discs are used.

If the pressure in the storage tank exceeds 240 psi one rupture disc will break and allow the ammonia gas to blow into the atmosphere. If this does not relieve the excess pressure fast enough, a second rupture disc at 260 psi will give way, reducing the pressure faster. As soon as the pressure is reduced and an operator can get to the valve, the escaping ammonia gas is shut off by closing a three-way valve, which opens up to another identical set of rupture discs. The ruptured set may then be replaced.

When unloading ammonia adequate safety equipment consisting of gas masks, rubber suits, gloves and head protectors are available for immediate use. These are usually placed on the windward side of the storage tank and pump house.

The storage tank is located adjacent to the dissociator room and ammonia gas is piped directly to the dissociators.

Dissociators—Preliminary studies showed that approximately 1600 cu ft per hour of dissociated gas (75 per cent hydrogen, 25 per cent nitrogen) would be required to form the necessary sodium hydride content of the caustic bath. It was thereupon decided that two 1200 cu ft per hr dissociators would be installed rather than one large unit. This would give the operating department greater flexibility, because in case of a breakdown of one dissociator, the descaling bath could still be operated at 75 per cent of capacity, thereby avoiding an untimely shutdown of unknown duration. Normally, these two dissociators are operated at 60 to 65 per cent of their rated capacity.

Dissociators shown in Figure 11 are of the nickel catalysis type and are fully automatic in their operation. The dissociated gas is piped by a 2 in. line to the generator boxes on the sodium hydride furnace.

Quench tank—The quench tank is constructed of $\frac{5}{8}$ in. thick carbon steel plates adequately braced. There is a slight taper to the longitudinal sides, the bottom width being slightly narrower than the top.

The inside dimensions are 41 ft-7 in. long x 6 ft-5 in. wide (top), 5 ft-5 in. wide (bottom), x 20 ft-0 in. deep.

The tank was made this deep to protect the operators and sodium hydride furnace from the splash resulting from the violent reaction caused by immersing the hot sodium hydride coated plates in the water. In normal operation the water is approximately 12 ft deep, leaving an 8 ft protective wall above the water level.

Water for the tank is supplied from the plant water system. The tank is equipped with a ventilating system, to exhaust the fumes, which will be described later in detail.

Sulphuric acid tank—This tank is constructed of $\frac{5}{8}$ in. thick steel plates properly braced and like the quench tank is wider at the top than the bottom. The inside dimensions of the steel tank are: 41 ft-7 in. long x 6 ft-5 in. wide (top), 5 ft-5 in. wide (bottom), x 11 ft-9 in. deep.

Tank lining—The inside of the tank was sandblasted and immediately coated with a rubber primer. A layer of a patented rubber sheeting (approximately $\frac{1}{16}$ in. thick) was then glued to the steel tank. This rubber sheeting was then tested inch by inch with an electrical spark tester to see that no pin holes were in this lining. A $\frac{3}{8}$ in. thick coat of a patented plastic cement was then applied and allowed to harden. The tank was then lined with 9 in. of acid-proof brick set in a special mortar

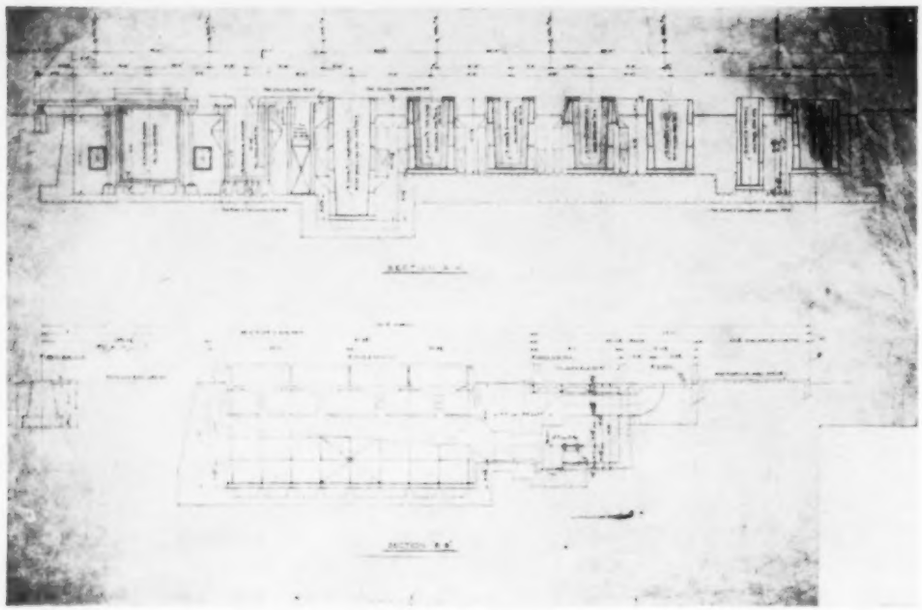


Figure 13 — General arrangement of the furnace and tanks.

applied in a molten condition. Since a submerged heating unit having a carbon pipe along the bottom was to be used, the bottom had an additional 9 in. layer of brick put on with a 9 in. wide channel running "catercornered" the length of the tank. This 9 in. channel was to submerge and protect the 4 in. carbon pipe from being struck by the individual plates or plate racks.

With the lining, the tanks now have an inside dimension as follows: 39 ft 14 in. long x 4 ft-11 in. wide (top), 3 ft-11 in. wide (bottom), x 10 ft-2 in. deep.

This tank like the quench tank has a fume exhaust system which will be described later.

The acid is heated by a submerged heating system with a blower which bubbles the hot products of combustion up through the liquid. The agitation accompanying this method of heating speeds the reaction and reduces the necessary pickling time as much as 50 per cent over that of the non-agitated tank.

Nitric-hydrofluoric acid tank—This tank is an exact duplicate of the sulphuric acid tank except for the lining. Carbon brick is used in this tank instead of the acid-proof clay brick.

Krupp acid tank—This tank, too, is a duplicate of the sulphuric acid tank except that the acid is heated by injecting live steam into the bath.

Water holding tank—Following the final dip in the hot acid tank the plates are ready to be spray-cleaned. It is impossible to spray-clean these large plates with a hose playing a stream of water on them as is done in other plants. Also, if the rack of plates was lowered in a spray-cleaning tank only the outside of the two outer plates would be cleaned. It is not practical to set the rack down and remove the plates for individual spray-cleaning because the residual heat remaining in the plates from the hot acid dip would cause them to dry off, and once dried, the smudge, remaining on the plates after the acid dip, is impossible to remove. Therefore, to keep the remaining plates wet while they are individually removed from the rack for automatic spray-cleaning a water holding tank was necessary.

This holding tank is a duplicate of the steel pickling tanks previously described. Approximately 9 ft of water is carried in the tank to submerge the plates. Naturally, the edges of the wider plates protrude above this water level. To keep these protruding edges wet a series of nozzles are mounted on the top of the tank and they "rain" a fine spray on the exposed plates keeping them wet. The plates are withdrawn from the submerged rack individually by means of plate "dogs" and taken to the spray-cleaning tank.

Spray-cleaning tank—To spray-clean each plate individually with hoses would require too great a loss of production time and excessive labor costs. It was therefore decided to install a pressure spray-cleaning system whereby the plate would be cleaned with one or more passes through a spray.

For this purpose a steel tank 41 ft-7 in. long x 3 ft-0 in. wide x 14 ft-11 in. deep was built. Headers of 4 in. pipe 41 ft-0 in. long with 82 spray nozzles spaced on 6 in. centers were mounted on the sides 25 in. below the top of the tank. Small holes were cut in the sides of the tank to accommodate the nozzles and the header placed so that the nozzles would be flush with the inside of the tank. This flush mounting of the spray nozzles assured that they would be protected without interferring with the effectiveness of the spray.

Two horizontal split case, double suction, ball bearing, volute centrifugal pumps having a capacity of 1300 cpm and driven by 100-hp, 2300-volt, 3-phase 60-cycle motors furnish the water required by the sprays. These pumps, located in the basement, draw their water from the spray cleaning tank pump it through a 16 in. strainer to supply the spray header with water at 110 psi.

The plate taken from the holding tank to be spray-cleaned is lowered into the tank, the sprays turned on and then the plate raised and lowered through the spray until clean.

The sprays are turned on and off by quick opening gate valves actuated by air cylinders, which in turn are controlled by hand operated 4-way valves connected to the plant compressed air system.

This spray-cleaning is fast and efficient, assuring that every square inch of the plate will be cleaned.

Coating tank—Since the water in the holding tank and spray-cleaning tank is cold it is necessary to dip the

Figure 14 — The welded racks which were originally constructed were not satisfactory and racks of bolted or riveted construction will be used when these are replaced.

plates into a tank of hot water to enable them to pick up sufficient heat to dry off quickly. This hot water is kept slightly on the basic side.

Originally, this tank was to be used for a cyanide coating dip but experience has shown that if the plate picks up sufficient temperature to dry quickly no coating is necessary.

Fume exhaust system on tanks—The three acid tanks and the quench tank have individual fume exhaust systems. This exhaust system consists of hoods which come up over the coping on top of the tank and are flush with the inside edge of the tank. These hoods are in turn connected to a main header along the side of the tank which in turn is connected to an exhaust fan. From the exhaust fan the fumes are forced through ducts to a stack outside the building. This exhaust system is illustrated in Figure 13.

Each acid tank has its own individual exhaust fan capable of exhausting 25,000 cfm. The main headers of the ductwork, however, are so arranged that any specific fan may be cut out, and the system still operate at 66 per cent of capacity. The exhaust fan on the quench tank has a capacity of 34,000 cfm.

The ductwork on all tanks is fabricated from $\frac{3}{16}$ in. thick carbon steel plates. The inside and outside of all the ductwork is painted (as is the outside of all tanks) with a $\frac{1}{8}$ in. thick coat of the special acid-resistant paint used to protect the steel work of the building. The impeller and interior of the fans was coated at the factory with a patented acid proof coating.

This fume control system is not 100 per cent effective due to the width of the tanks, but it does diminish the fumes to such an extent that no complaints have been made so far. However, for anyone installing a new exhaust system on tanks as wide as those at Lukens, a push-pull exhaust system would be more effective, we believe.

HANDLING EQUIPMENT

Plate racks—Racks to hold the plates to be descaled were designed and made from 18-8 moly stainless steel plates. Welded construction was used throughout, though this welded construction has not proved quite satisfactory for metallurgical reasons. When necessary to replace these racks bolted or rivited construction will be tried. The racks (welded) now in use are shown in Figure 14.

Acid handling—At the present time the concentrated nitric and sulphuric acid is received in 10-gal carboys, weighing approximately 200 lb each. To attempt handling these carboys and dumping them into the tank by hand would be extremely dangerous. Special wheel trucks for lifting the carboys are used as shown in Figure 15. These wheel trucks are used to bring the acid from storage and to place each carboy in the dumping box.

For dumping acid into the tanks a steel box into which the carboy is clamped is used. This box is lifted by the crane by means of a spreader bar and trunnion hooks. The trunnions are slightly below the center of gravity of the box so that when the latch on top is released the box will rotate 90 degrees so that the mouth of the carboy is at the bottom, the acid of course pouring out.

Sodium barrels—For handling the sodium barrels special barrel-handling wheel trucks are used, similar to those used for handling the carboys of acid.

Sludge removal—Sludge is removed from the sodium hydride tank and the quench tank by means of a grab bucket built in the weld shop. This grab bucket is very simple.

Acid disposal—In compliance with the state law regarding stream pollution, an acid disposal system to dispose of the spent acids was built.

CONCLUSION

The above described sodium hydride descaling system at Lukens has been in operation slightly less than six months. Up to the present time the optimum in the cycle of operations has not been reached, yet each month of operation indicates an increase in the efficiency of operations. It is believed that time and experience will enable the operating department to achieve the expected speed and efficiency in descaling stainless and stainless-clad steel as originally anticipated.

Figure 15 — Special wheel trucks are used to handle the carboys of acid.

IMMERSION GAS TUBE PROCESS OF DESCALING BAR STEEL

By G. D. MUSCHLITZ, Assistant Master Mechanic
The Midvale Company
Philadelphia, Pennsylvania

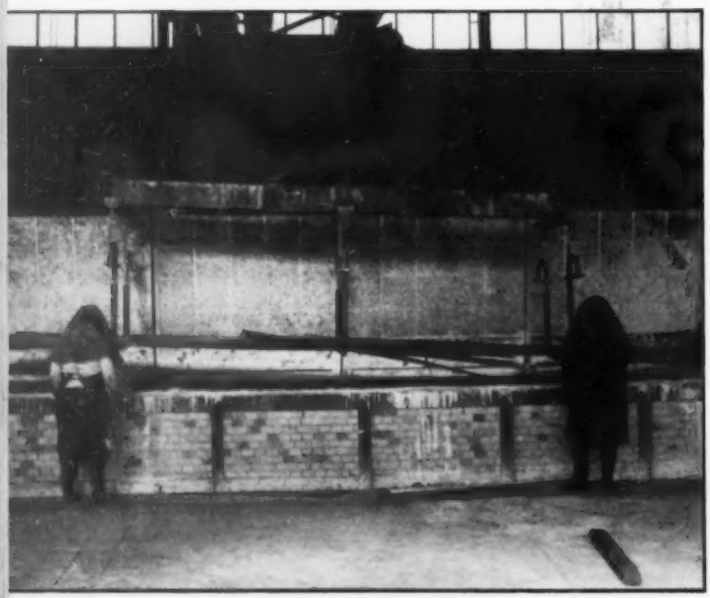
▲ THIS paper covers a generally similar process to the one described by J. S. Morris but differs in several respects:

1. Size of baths—ours being much smaller.
2. The Hooker process has a much higher operating temperature.
3. Gas fired immersion tubes for heating.

The Midvale Company has had little experience with large salt baths for the removal of scale, and installation of this equipment was occasioned several years ago due to the purchase of a large bench for drawing stainless and high alloy bar stock. As most operators know, bars must be completely scale-free before cold drawing since slight particles of scale will ruin even carbide dies, producing scratches or otherwise marking the finished cold drawn product.

This paper applies only to the descaling of the 300 and 400 grades of stainless steels, as the low alloy steels are successfully descaled by immersion in dilute sulphuric acid which removes the scale with little loss of base material. However, chrome nickel scales are highly resistant to sulphuric acid and previous to development of the hot salt bath descaling methods, these high chrome nickel bars were descaled by mechanical scale breaking processes followed by long time immersions in hot hydrochloric acid or combinations of hydrochloric and hydrofluoric acids. This method caused a high loss of base material plus a high loss of acid due to the long immersions.

Figure 1 — Protective clothing is used by the picklers handling the material to eliminate accidents from splashes when the piece is dropped in the bath and also to afford protection when dipping the steel into the water.



HISTORICAL BACKGROUND

The salt bath is not an innovation to the steel industry and its development covers many years of research, probably dating back to the Lavite system which was used for many years to descale the high carbon tool steels and now common in the steel industry for treatment and carburizing, etc. It has disappeared many years ago as a descaling agent, not because of its inability to remove scale, but because of the necessity of heating the molten salt in direct fired carbon crucibles and, therefore, boosting the carbon steels to even higher carbon content. This system involved the use of molten salt into which the steel was immersed, followed by a dip into cold water. The resulting blast of the molten salt which had gripped the scale cleaned the bars of impurities. I repeat that this system was not too successful with the carbon steels and entirely unsuccessful with the stainless steels.

The Lavite system was mentioned for an example of scale removal by a physical or mechanical action, as undoubtedly the gripping of the salt around the scale and the blast in the cold water can only be described as such.

CHEMISTRY OF BATH

The Hooker process apparently combines a chemical reaction with the identical physical or mechanical reaction just cited. As regarding the chemical reaction, we fear we must deal in hypothesis. Where Mr. Morris can definitely illustrate the chemical reaction of converting the oxides to base metals and simultaneously forming caustic soda which is the carrier bath, we must speak in generalities. Reference is made to the patent for the process and quoting: "While we do not wish to be held to any particular theory as to the reactions that take place in our process, it would seem that the fused caustic alkalies form the corresponding salts of the metal oxides which are generally black, but sometimes a very distinctive reddish brown and that these salts being basic, as well as quasi-molecular, are very reactive with acids. It appears that the presence of the oxidizing agent promotes the formation of these salts."

The developers of this process have not offered the recipe of their method, so we must again refer to one of their patent claims which is a bit broad. We quote: "The method of removing from the surface of chrome-nickel 'stainless steel,' dense firmly adherent oxide that has formed thereon through exposure to air under oxidizing conditions which comprises subjecting the oxide to the action of a fused substantially anhydrous bath, comprising caustic soda containing five to fifteen per cent sodium nitrate, said bath being at substantially the same electrical potential as the metal, at four hundred to six hundred degrees C for not less than one minute and subjecting the modified oxide to the action of five to fifteen per cent aqueous hydrochloric acid."

TREATING CYCLE

The general run of bar stock enters this plant directly from the rolling mills. A typical treating cycle consists of the following steps:

1. Annealing.
2. Fifteen minute immersion in the salt bath.
3. Quick dip into the cold water tank.
4. Five minute immersion in the hydrochloric acid tank.
5. High pressure water rinse.
6. Five minute immersion in the nitric acid tank.
7. High pressure water rinse.
8. Five minute immersion in the cleaning solution tank.
9. Immersion in the lime tank for lubrication preparatory to cold draw.
10. Cold drawing.

The material is handled on suitable racks as shown in Figure 1. This figure shows the point in cycle where the bars are being removed from the salt bath and allowing the excess liquid to drain back into the tank, thus decreasing the drag out. This comparatively light load is sustained by three supports upon which it rests during the entire cycle, thus allowing batches of steel to be in all the baths if necessary. Note the protective clothing worn by the picklers. These hoods and protective masks would not only protect them in the event of a piece dropping into the bath and splashing them, but also affords protection when dipping the steel into the cold water which blasts the scale and sends it all directions.

EQUIPMENT

The decision of the management to use a salt bath method of descaling was important but to the mind of the maintenance men, it was only incidental to the selecting of a method of heating this bath to a required 950 F and possibly 1100 F temperature. Three plausible methods of firing presented themselves:

1. The externally fired pot.
2. Immersion electrodes.
3. Internally gas fired immersion tubes.

The externally fired pot was ruled out because of the ever present danger of the human frailities of a heater who might allow a burner to blast a hole through the side or give an uneven heat which might rip a seam in the tank.

The clean and less troublesome immersion electrode heating was discarded in view of the high cost of electricity, and it was decided, therefore, to use gas as the heating medium. Before we go into more details of the economy, we will describe the construction of the bath or furnace. Figure 2 shows a picture of the entire furnace.

The entire bath is contained in a concrete walled and floored pit, holding a steel tank approximately 5 ft deep x 4 ft wide x 31 ft long, half its height being below floor level and resting on an insulating concrete mixture about 9 in. thick. The side walls consist of a 9 in. insulating firebrick against the steel tank and a 9 in. wirecut firebrick on the outside contained by a structural steel framework.

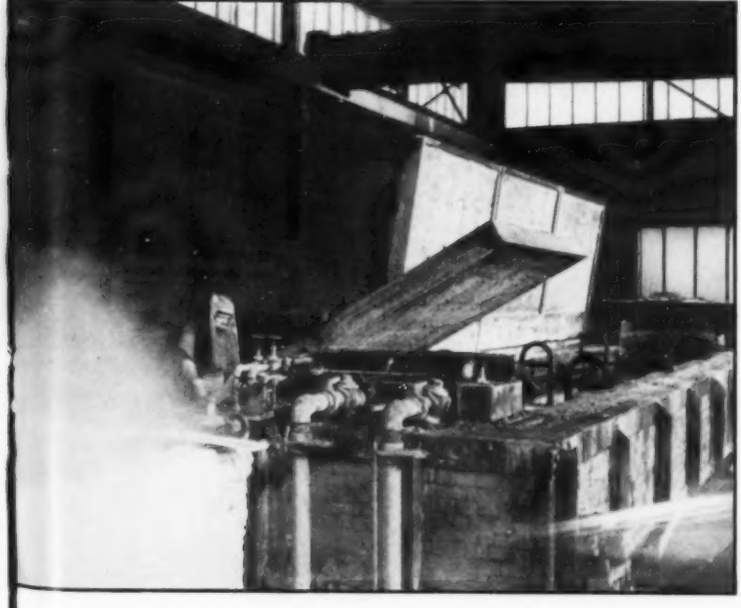
The four immersion tubes, invisible here, are arranged so that two burners are on one end and two on the other. They are in the form of a square "U." Naturally, the buoyancy of the salt is tremendous and it was necessary for us to connect the four tubes with seven structural steel supports with steel rods secured at the top of the tank and holding the tubes down to their required level. A grid constructed of rails not only protects the tubes from injury, but also counteracts the buoyancy of the liquid salt.

Figure 3 shows the heavy covers that are counterbalanced so that one man with a 25 or 30 lb pull can easily open or close them. These covers are insulated with a light refractory and steel plates protect them from injury. We might add here that these covers were designed to serve not only as insulation when nothing is in the bath, but also as shields for washing of the bars following their removal from the hydrochloric and nitric acid baths. We were considerably concerned about the reaction of accidently turning a spray of water into this 950 F bath, but we have seen considerable spray hit the bath without any apparent commotion resulting. Very likely, the great heat arising from the molten salt vaporizes the water before it actually reaches the salt. Figure 4 shows a close up of the burner.

You will note two of the four tubes terminate on this end of the bath and the other two on the opposite end. The burners are castings, flange connected to the top of burner tubes with heat resisting burner nozzles. Figure 5 shows the gas booster room.

The city gas line enters at the left corner of this room controlled by an automatic shut-off valve which will immediately stop all gas flow to the booster in the event of a power failure. From this valve the gas is boosted from city pressure to 15 oz by the 225 cu ft per minute booster, from its discharge to the proportioning valve which proportions the amount of air from the air compressor, always maintaining the same ratio of air to gas

Figure 2 — The furnace tank is about 5 ft deep, 4 ft wide and 31 ft long. Half of its height is below the floor level.



regardless of the valve opening. This valve is opened and closed by a controller which is actuated by a chromal alumel thermocouple inserted into a protected tube in the bath. This system also services the annealing furnaces which accounts for the second proportioning valve, and the two other pipe lines.

Returning to Figure 4, the large line is the secondary air from the proportioning valve and the smaller, the gas line. On the left you will note a raw gas line with regulator and compressed air lines which feed the pilot burners, and I might also call them auxiliary burners, inasmuch as they hold the temperature drop of the bath for weekend shutdowns to approximately 160 F in 48 hours. The total gas consumption in this period being about 9000 cu ft or approximately five dollars worth. It is, of course, necessary to throw on the main system four or five hours previous to using the furnace to bring back the bath to its 950 F operating temperature.

ECONOMY OF OPERATION

Optimum thermal efficiency results when combustion takes place within or below the surface of the solution or liquid to be heated. The additional expense of extra heavy insulation was justified during non-productive hours and the extra volume of the tank enables continuous production with little or no drop in temperature and a reserve of heat that has already proved its value at times of tube failures. Tests made during production show that an average of 3000 cu ft of 530 Btu gas is pumped into the furnace per hour. In this type of heating where the purpose is to remove scale and not to heat the steel, we can only speak of a heat transmission efficiency. Although the American Gas Association claims that for submerged type gas tubes with liquid back length of 35 ft, not including the stack riser and a burner input of 3000 cu ft per hr there is an 80 per cent thermal efficiency, we prefer to speak in terms of more tangible and conclusive results; namely, any outside portion of the furnace can be touched by hand and the flue temperatures are within 10 or 15 degrees F of the bath temperature.

COMPARISON WITH OTHER TYPES OF HEATING

For purposes of comparison, let us assume that it is necessary to put 1,260,000 Btu into the furnace on the basis of the 3000 cu ft per hour demand of gas. This would require about 369 kw at one cent per kilowatt or about $3.69 against $1.65 per hour for gas. It is obvious that for our plant, it would take more than 100 per cent efficiency to balance the two costs.

OPERATIONAL EXPERIENCE

We have mentioned before that the scale is loosened in the hot salt bath or to be more technical, converted from an oxide to a salt promoted by the oxidizing agent, but breaks loose in the quick dip into the cold water bath immediately following the removal of the steel from the bath. We believe you will agree that this factor in itself is one of the process's most important advantages. Although the manufacturer claims that the scale that does break loose in the bath is completely dissolved, continuous settlements would logically lead to deterioration of the salt. We have found little or no sediment resting on the tubes and grids when repairs were made.

We went to considerable expense to construct the immersion tubes of 50 per cent clad, Grade 347 stainless steel on the inside of the tube and low carbon steel on the outside of the tubing with a specified thickness of $\frac{3}{16}$ in. equally divided. At the end of five months, the first tube failed and in rapid succession two others sprung leaks on the firing end. Up until this time we had had no experience as to the life expectancy of the tubes and were forced to repair with a 6 in. outside diameter with $\frac{1}{4}$ in. wall low carbon steel tubing. We had noted with some alarm a red glow on the firing end of the tube at the salt line. The constant rise and fall of the salt line when loads were inserted and removed apparently was corroding this portion of the tube. Very likely, the exposure to air of this point of the tube which probably reached a temperature of 1400 F caused oxidation which was removed by the salt. This action is repeated every time a load is inserted. With this in mind, we inserted $5\frac{1}{4}$ in. inside diameter, 25-12 heat resistant steel liners from the burner to below the salt line of the bath. The above repair was accomplished in three steps and when the customary red glow did not appear we felt we could breathe again. Construction of a set of immersion tubes of low carbon steel with heat resistant liners approximately 23 in. long at the firing end was begun and subsequently installed six months later upon failure of the partially stainless steel tubes, and at this writing we have passed our sixth month without casualty.

The salt freezes at about 550-600 F and although we have never been faced with this freezing problem, it

Figure 3 — Furnace covers are counter-balanced so that one man can easily handle them.

does haunt us and considerable thought has been put to it. We have been assured, and tests made by us verify the statements that the mixture does not expand upon freezing which might open the seams in the tank or crush the immersion tubes. We have also been advised that no difficulties will arise from heating the solid mass, but as we have previously stated we have not had to put this to test and we fear it would be a long and tedious process which could result in the ruination of the burner tubes if the heating were not carefully regulated.

In speaking of the treating cycle, we referred to the general run of material and we must explain that there are more exceptions than rules and more material requiring special treatment than this "so-called" general run of material. Experiment has shown us that there are certain "Do's and Don'ts" to which we are continually making additions as the cases arise:

1. Prolonged exposure (thirty minutes to one hour)

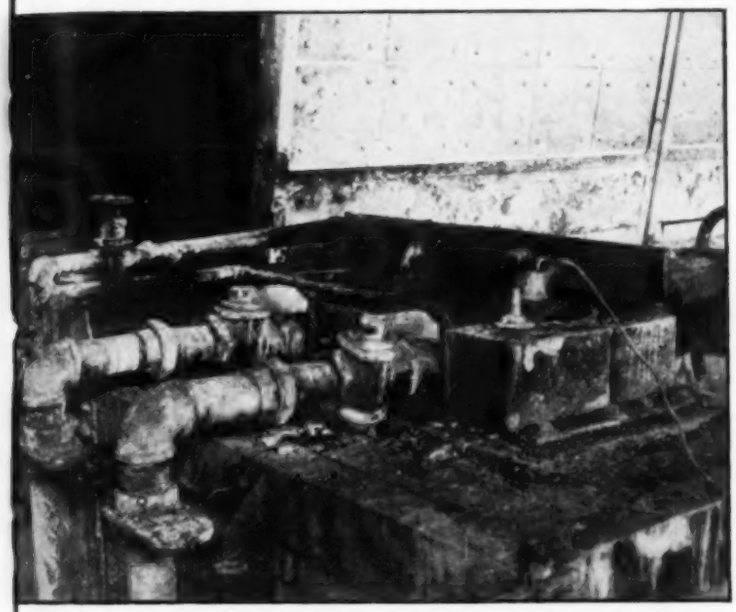


Figure 4 — Burners are made of castings which are flange connected to the top of the burner tubes with heat resisting burner nozzles.

is of little use and for ordinary light scale a fifteen minute immersion in the bath is ample plus the HCl and HNO_3 dips.

2. Using a fifteen minute immersion, satisfactory results were obtained if the scale was uniform and light and if the bars were quite smooth and if the temperature of the hydrochloric acid was kept at 170 F or above and if the bars were not cooled off too long in the water dip and finally if the acid concentration were held at nine per cent or above (up to eleven per cent).

3. If the bars were not smooth (as usually is the case) it was found that two trips through the bath using the fifteen minute immersion period and the acid dip after each were much more effective than any prolonged soaking in the salt. This action again substantiates our theory that the descaling action is mechanical.

4. We have tried a three or four second dip in the hydrochloric acid prior to putting the bars into the bath. In general, this appears to be slightly advantageous

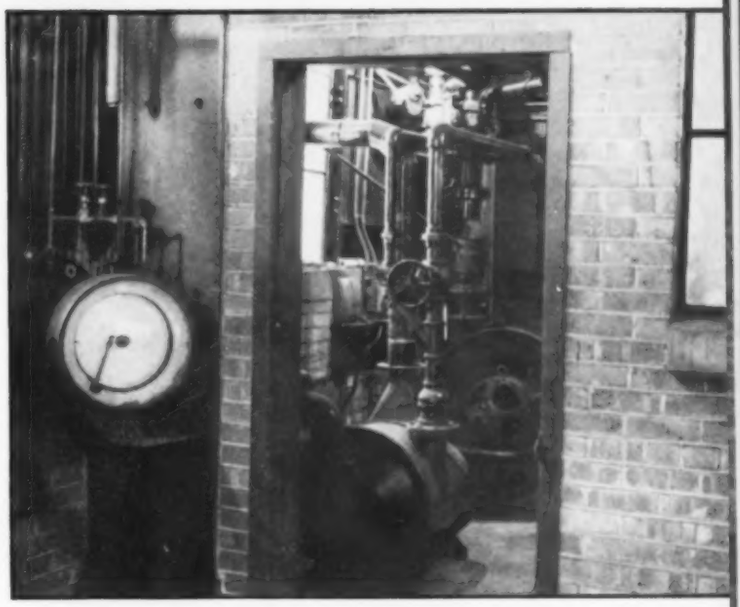


Figure 5 — It is necessary to boost the gas pressure from city pressure to 15 ounces.

insofar as removing the scale was concerned. The objectionable feature was that the great body of loose scale fell into the acid which was just what we did not want from the standpoint of acid economy. Also, the fumes from the acid dipped bars were often objectionable when the bars were placed into the salt.

5. If, as occasionally happened, the coils or bars were so located in the annealing furnace that direct flame impingement occurred, a degree of adherent scale developed which was simply beyond the capabilities of this salt-acid system to remove. In such cases, we found no way of removing the scale from the injured areas without ruining for all practicable purposes, the areas lightly scaled. This was true only because long acid dips between the immersions were successful. The same thing was true of several groups of bars, both stainless (four hundred series) and low alloy constructioned steels annealed in other furnaces. No amount of treatment availed in such cases and it was necessary to grind the bars clean before cold drawing.

6. The temperature of the bath is important and should be 950 F or above (except that at 1100 F attack of the steel tank and any other submerged material becomes rapid, and also the salt becomes dangerously hot).

SAFETY OF OPERATION

The innocent appearance of this 950 F bath is completely misleading. Outside of the great radiation of heat from the open furnace, you would not suspect the potential dangers lurking beneath the surface. To date, we have had no accidents greater than light burns, but extreme precautions are taken for both operations and repairs. Rubber clothing and plastic masks are used by operators and they have been well acquainted with the dangers of physical contact.

DISCUSSION

PRESENTED BY

G. H. GREENE, Chief Engineer, Bethlehem Steel Company, Steelton, Pennsylvania

N. C. BYE, Director of Engineering, Henry Disston and Sons, Inc., Philadelphia, Pennsylvania

HORACE DREVER, Drever Company, Philadelphia, Pennsylvania

H. L. GIFFORD, Supt. of Heat Treatment, Bethlehem Steel Company, Bethlehem, Pennsylvania

DONALD B. FULMER, General Foreman, Cold Drawing Department, Bethlehem Steel Company, Bethlehem, Pennsylvania

WILLIAM N. HORKO, Engineer, Henry Disston and Sons, Inc., Philadelphia, Pennsylvania

F. C. SCHOEN, Engineer, Midvale Company, Nicetown, Philadelphia, Pennsylvania

M. F. HARR, Assistant to Chief Engineer, Bethlehem Steel Company, Bethlehem, Pennsylvania

CLYDE S. CASSELS, Henry Disston Sons, Inc., Tacony, Philadelphia, Pennsylvania

M. H. LEBOWITZ, Supt. of Finishing, Carnegie-Illinois Steel Corporation, McKeesport, Pennsylvania

G. H. Greene: I would like to ask of Mr. Muschlitz if he is using other than a gas tube immersion burner.

N. C. Bye: I would like to ask Mr. Morris to clear up a few points for me at this time. Having had some experience in starting small salt baths, I would like to know the procedure in starting up this the largest salt bath in the world; in particular, the amount of time from initial heating until the bath is ready to run. I would also like to know the cleaning time on the sodium hydride furnace either in intervals of time, mass of material or with material going through. Is the drag-out from the sodium hydride tank a total loss or is there an attempt made to reclaim it? Also, as this is a very deep salt tank, I am interested in knowing the temperature variation between the top of the tank and the bottom of the tank when there is no mechanical agitation and how far the electrodes project down into the tank toward the bottom.

You mention that the cleaning water used on the spray tank for washing off sludge is recirculated. Do you anticipate any trouble from dirt in this cleaning water during recirculation contaminating the plates that have been put in the tank for cleaning?

The next question is directed to Mr. Muschlitz. While Mr. Morris talked of the desirability of mechanical agitation to equalize temperatures, you made no mention of mechanical agitation or temperature differential at all. Is this because most of your work is confined to one level in the tank so temperature variation would have little effect on the character of the work, or is there a difference in the operating characteristics in your type of equipment as far as circulation is concerned as compared to Mr. Morris' type of equipment?

Horace Drever: We have operated both the Hooker salt bath and the sodium hydride processes and, frankly, I do not think anybody has yet the whole answer to the problem of descaling by salt.

Our experiments indicate you have got to start with your furnace before you get to the salt bath. Control your oxides and your salt bath descaling is rather simple. In carbon steel or stainless, and I do not care what the analysis, you have a certain oxide that is easiest to attack. That is true of pickling as well as of salt descaling. Nobody yet knows the correct answer to the oxide on stainless steel. I think, fundamentally, with any method of pickling or salt descaling we have got to go further than we have yet. Get down to the proper chemical composition of the oxide; try to condition your steel before it gets to pickle or salt descale, and your answer will be comparatively simple.

H. L. Gifford: We likewise have a salt bath descaling unit. We have had it since about the 15th of December, 1947. We do not know all about it yet and possibly we never will. We have not used it on anything except the so-called engineering steels, the SAE, the NE, some carbon (very little) being an alloy plant. Ours is externally heated. It is the salt bath process. I do not know just why Bethlehem bought this. They call the salts "Virgo Salts" which is a trade name.

Anyhow, we have used that bath, and the manufacturer's people recommend certain temperatures for certain kinds of steel. Those temperatures do not vary much, running betwen 940 and 970 F, which to me is not much. We put a bundle of steel in there and it will drop that much, or more than that, say 50 F, and it takes twenty or thirty minutes anyhow, to come back to temperature. We are doing, we will say, 3140 in one batch, and 4150 the next and 1050 the next, and so on—and so we go, all day long. It is a tough job to control a bath 25 or 28 ft long, 6 or 7 ft deep and 4½ ft wide, with such specific instructions as those, and I just wonder if anybody at Midvale has had this experience with temperatures?

Donald B. Fulmer: I would like to ask Mr. Muschlitz a few questions. One, what strength is the nitric acid? Is it used hot or cold, and what is the temperature?

What special solution does Mr. Muschlitz specify? What type of racks are they using and what sort of metals are they using in them? When the steel is not clean and is returned through the cycle, is there any violent reaction if you put the bars back wet or do you have to dry them off first? Also are you able to clean the bars up for cold drawing without separating them in your racks?

William N. Horko: How often is it necessary to remove sludge from the tank?

How many pounds or square feet of steel can be descaled per hour?

The third question I have is on the possibility of an explosion. As I understand the system, hydrogen is passed through the salt after it has become molten. Is the volume between the salt and the cover purged of air before the gas is permitted to flow? If this is not done, it would seem to me there is the possibility of an explosion.

F. C. Schoen: Mr. Gifford mentioned he was external-firing salt baths at Bethlehem. I am wondering what provisions were made in case of a leak in that type of

tank? With external firing there is always a fear of burning and leaking. It is one of the reasons we did not go to the system of the large pit with chains down in it, with the piece of solid salt perhaps too heavy to lift with overhead cranes. I wonder how Bethlehem is taking care of that problem?

M. F. Harr: When installing our direct-fired salt bath the question of a breakout of the salt pot was approached in two ways. Our first thought was to prevent breakouts and to this end we purchased a multi-burner, soft-flame furnace on the premise that many burners would tend to prevent overheating. To further prevent overheating an eight point controller was placed in the firebox so that firebox temperatures would remain below a predetermined maximum regardless of salt temperature. Thirdly our pot (of 1½ in. plate) was sprayed with aluminum to resist oxidation.

Although we believe these precautions will prevent a breakout, our second approach to the problem was to attempt to minimize the damage in the event the salt did break out. Surrounding our furnace is a pit of greater volume than the salt pot. At spaced intervals in the pit are placed 3 x ½ in. straps made in a U-shape to conform to the contour of the pit. In the event of a breakout the solidified salt would be drilled at suitable intervals and pulled from the pit in chunks by means of the straps and the overhead crane. A still further precaution was the purchase of a special pump with which we can pump the molten salt into steel drums, outside, or any other suitable place where it cannot do appreciable damage.

Clyde S. Cassels: In what condition is the salt when you get it, and how do you get it when starting the bath?

John S. Morris: In answer to Mr. Bye's question on how long does it take to get a unit started, and how did we do it? Naturally to have any passage of current between the electrodes, which are hanging in mid air 3½ in. apart, there has to be some liquid for the current to pass through. We took flake caustic soda and piled it into the tank to a depth of approximately three feet, surrounding the electrodes with it. We then took some gas burners about 14 feet long which were made from 1 in. pipe, having a natural gas and compressed air inlets on one end, and fired down onto the flake caustic adjacent to the electrodes until a puddle of molten caustic was formed around the electrodes. Figure 16 shows a view of the engineers firing against this flake caustic to form the molten puddles. It required about 2½ to 3 hours to get any visible signs of current flowing between the electrodes. Once a puddle was formed around the electrodes they started to work and continued to melt the caustic. It took about two days to melt all of the flake caustic and then we started adding solid caustic till the bath was the proper depth. It required about twelve days from start to finish. Before starting to add metallic sodium the caustic bath was dehydrated by using sodium monoxide.

Mr. Bye asked what the cleaning cycle was. As previously stated in the paper, in discussing the time cycle with the operators we realized that the cycle of operations would depend on the time the plate had to remain in the sodium hydride, and for that reason we installed the preheat furnace. We have found that the sodium hydride bath is not the bottleneck. Our cycle is determined by the time required for removing the plates individually from the water holding tank and spray cleaning them. Therefore, we hold the plates in the sodium hydride longer than is necessary. We understand from Mr. Lebowitz that, with our preheated plates, six minutes would be long enough. At the present time our cycle in the sodium hydride is approximately twenty minutes, because of the bottleneck in spray cleaning.

Figure 16 — Gas burners are used to start the meltdown of the flake caustic forming a pool at the base of the carbon electrode in order to get current flowing between the electrodes.

Max H. Lebowitz: That figure of six to eight minutes was quoted on the basis of when the material had arrived at temperature, and also the hydride content.

John S. Morris: We maintain our hydride content at 1½ to 2 per cent, which is recommended by the manufacturer. Our plates go in the bath at 700 F so we could theoretically have a cycle of approximately six minutes.

Mr. Bye asked about the drag-out. Did you mean the drag-out of sodium hydride over into the quench tank?

N. C. Bye: Yes.

John S. Morris: As was stated the reaction between the scale and sodium hydride forms caustic soda. Therefore, we get a build up of caustic soda and have to bail it out into barrels. This is because our square inches of plate per ton of steel descaled is not as great as that of operators descaling light gage plates, and consequently our drag-out due to surface coverage is not as great.

As to sludge removal we have only had to remove sludge once since we started operating. This was about

three weeks ago, and at that time we only took out about five scoop-fulls. This sludge was of no use whatsoever.

As to temperature variations we maintain a temperature of 700 F in the sodium hydride bath and since the plates are preheated to 700 F, there is no perceptible drop in temperature. The recent cold spell caused the gas company to shut off the gas so it was not possible to preheat the plates. When a rack of cold plates was immersed in the hydride bath the temperature would drop to approximately 670 F. Now as to the variation of temperature between the top and bottom of the bath which Mr. Bye asked about, as stated the normal operating depth is 11 ft-6 in. and normal temperature taken 3 ft from the surface is 700 F. A check shows that there is a variation between the top and bottom, the bottom being colder:

1 in. off the bottom, 615 F.
4 in. off the bottom, 625 F.
18 in. off the bottom, 670 F.
36 in. off the bottom, 700 F.

Therefore, we feel that there is need for mechanical agitation.

Mr. Bye also asked about the length of the electrodes and spray water contamination.

The electrodes extend to within 18 in. of the bottom of the tank.

The spray cleaning water is drawn from the tank, forced through a strainer which removes the major portion of the sediment so the spray nozzles do not get clogged. The water is kept slightly on the basic side by the addition of soda ash. When it becomes too dirty, the tank is drained and refilled with clean water.

Mr. Gifford assumed that we dealt only with stainless steels. That is not correct. In the Lukens installation we descale solid stainless, nickel clad, monel clad, inconel clad and stainless clad steels. These clad steels have a carbon steel backing plate and the hydride cleans the carbon steels very successfully in spite of the fact that the scale is much heavier on the carbon steel.

Mr. Horko asked about sludge removal; the pounds or square feet of steel that can be descaled per hour, and the possibility of an explosion from the hydrogen. As stated previously we have removed sludge only once. The pounds or square feet it is possible to descale depends on the gage of the plates processed.

On the danger of an explosion from the hydrogen in the generator boxes, the generator boxes extend about 20 in. down in the motlen caustic with 8 or 10 in. protruding above the surface of the bath. The hydrogen is forced through a 1 in. pipe extending about 18 in. in the caustic in the generator box. If this hydrogen mixed with oxygen in sufficient quantities there would be danger of an explosion. However, we have an inspirating gas burner over the vent hole in the generator box so that the excess hydrogen is burned as it escapes. Since this gas burner burns continuously any excess hydrogen is burned thus eliminating any danger of an explosion.

Mr. Harr spoke on the precautions which were taken in the event of a "break-out" on their salt pot, such as a multiple number of soft flame burners, eight point controllers, spraying the pot with aluminum to prevent oxidation, and the installation of V-shaped straps to lift out the solidified caustic if it did break out and go in the furnace pit.

I would like to suggest that if this pot had been made with Lukens stainless clad, with the clad side next to the firing chamber to resist oxidation some of those elaborate precautions would not have been necessary.

G. D. Muschlitz: Mr. Greene asked if we had any experience with any other burners than gas. I can only answer by saying, no; we had no other consideration but gas. The mere fact that the furnace is designed for gas, if we used any oil it would be, of course, light oil, and we had no light oil in that vicinity.

Mr. Bye asked if we had any method of agitation. We do not, but the salt has a natural convection of its own, a little bit more than most liquids, which amply takes care of that.

I do not have accurate temperatures of the top and the bottom as has, Mr. Morris, but it apparently is fairly constant. The tubes naturally extend along the bottom, four tubes which tend to send up the heat. The loads are inserted through their own agitation, that is the loads that we put in are just about the size of the bath. The bath is approximately five ft deep and therefore there would not be a great deal of temperature differential between the top and bottom.

Mr. Gifford asked about scaling low carbon steels. I believe I did mention that low carbon steels are successfully descaled by pickling and I rather passed over that pretty quickly. We can and have done a lot of low carbon steels with great success, but I am dealing mainly with stainless steel. Stainless steel cannot be descaled by pickling. When you do that you are putting it in the hot concentrated sulphuric acid, which is eating the steel. It was asked what the temperature of the nitric acid was. It is 170 F and it is important to keep it at that and above. The racks we use are 25 per cent Cr and 12 per cent Ni, heat resistant, and approximately an inch and a half thick. We have had no trouble with them up to this point.

I did mention that we returned some steel, that is, we put it in the furnace and dip it in water, and it is returned again to the furnace. Naturally it is wet, if you would dip it into there immediately, there would be violent reaction, but the operators when returning it to the furnace allow it to dry a few seconds. A few seconds is plenty, because there is a tremendous amount of heat.

We do not separate the small diameters of steel in the racks, that is, the small diameters, I am speaking of quarter inch to say, five-eighths inch. They are handled in maybe 1000 lb bundles. The larger diameters are separated.

I may be repeating Mr. Morris, but whether it was directed at me or not, I do not know. The sludge in our tank is practically negligible. We find very, very little when we change the tubes. One of the claims of the manufacturer is that there will be no sediment, or that any sediment that is loosened and falls into the tank, (and it should not loosen) is fully dissolved.

Mr. Cassels asked what condition is the salt when it is first installed, that is, starting up? It comes in drums of 400 lb each, and resembles soap flakes in all varieties, and all colors of the rainbow.

Fits, Tolerances and Finishes

. . . . standardization of fits, tolerances, and finishes by the steel industry, as carried out by the American Standards Association and Association of Iron and Steel Engineers, is resulting in plant economies . . . . since machining costs for a particular piece can vary through a ratio of 40-1, depending on the finish used, the roughest finish which results in satisfactory operation should be specified . . . .

By MYLES F. HARR, Assistant to Chief Engineer
Plant Engineering Department
Bethlehem Steel Company
Bethlehem, Pennsylvania

▲ INDUSTRY in the past several years, has become increasingly aware of the need for standardization of fits, tolerances and surface finishes. To fill this need, the American Standards Association has developed several pertinent standards, a standard for fits and tolerances being evolved as early as 1925 (with a 1947 addendum), while the final finish standard was published in February, 1947. It is the purpose of this paper to show how our company and corporation modified these standards to make our own standards and how we propose to put them into practice in our plants.

FITS AND TOLERANCES

To review the ASA's 1925 report on "Tentative Standards for Tolerances, Allowances and Gages," we herewith present a brief summary of this report. The standard consists of eight classes of fits, each class progressively decreasing the clearance and/or increasing the interference between mating parts. The first four of these classes, loose, free, medium and snug, are suitable for interchangeable assembly (i.e., any given shaft will suitably fit any hole of the proper nominal size); while the last four classes—wringing, tight, medium force, and heavy force are designated for selective assembly wherein the shafts and holes are measured and matched before mating. Since the standard is based on the basic hole principle, the hole is held to nominal size while all allowance is placed on the male member. Charts are included in the ASA report showing the tolerances for sizes up to 7 or 8 inches in most cases; for sizes above this, formulas are given with which one can work out hole and shaft tolerances and allowances.

As far back as 1926, our plant had instituted a standard of fits and tolerances based upon the ASA report of 1925. This standard similarly adopted the basic hole principle, consisted of only five classes of fits, and was entirely based on interchangeable assembly as opposed to selective assembly. The basic hole principle was adopted for the simple reason that it is easier to hold the bore to size and vary the shaft than is the converse, especially since standard reamers are made to nominal size. Only five classes of fits were selected because at that time the standard was used mostly by the heavy machinery division and no need was felt for the looser fits. The fits selected were Class No. 2 (free), No. 3 (medium), No. 4 (snug), No. 6 (tight), and No. 8 (heavy force). Since the standard was used on heavy machinery manufacture and not on mass production there was little opportunity for selective fitting, and perforce the principle of interchangeable assembly was followed throughout.

In 1938 our Maryland plant developed independently a similar standard based on the 1925 ASA report. This standard had six fits which included Classes No. 1, 3, 5, 7, and 8 plus a "clearance" fit which was a looser fit than the loosest one in the ASA standard. The need for this very loose fit was most evident at such places as the blooming mills, or where ever excessively hot conditions were encountered. The ambient heat at such points causes large and uneven expansion so that mating parts with just normal clearance will have interference when heated to operating temperature. An example of this type fit is the fit between table rollers and their bushings on a blooming mill table.

In 1947, these two standards were combined into one corporation standard. The fits chosen for this standard were the clearance fit, just described, and Classes No. 1, 2, 3, 4, 6, and 8. This gives a standard of seven fits which we feel will cover all conditions encountered in our type of work. An illustration of the method in which our standards are charted is shown in Figure 1 which is a portion of our "Tight Fit" standard. This chart is shown not for the sake of the information it contains but to demonstrate the ease with which it is used. Thus the sizes and tolerances for the male and female members of a ten-inch nominal size would be:

Presented before AISE Philadelphia District Section Meeting, November 1, 1947

TIGHT FIT ALLOWANCES & TOLERANCES

SIZE	FEMALE MEMBER			MALE MEMBER			MINIMUM TIGHTNESS	MAXIMUM TIGHTNESS
	ALLOWANCE	TOLERANCES +	TOLERANCES −	ALLOWANCE	TOLERANCES +	TOLERANCES −		
0" TO NOT INCL. 1/8"	0	.0005	.0000	+.001	.0000	.0005	.0000	.0010
1/8" " " " 1 1/2"	0	.0005	.0000	+.0015	.0000	.0005	.0005	.0015
1 1/2" " " " 2 1/2"	0	.001	.000	+.0020	.000	.0005	.0005	.0020
2 1/2" " " " 3 1/2"	0	.001	.000	+.0025	.000	.001	.0005	.0025
3 1/2" " " " 4 1/2"	0	.001	.000	+.003	.000	.001	.001	.003
4 1/2" " " " 6"	0	.001	.000	+.004	.000	.001	.002	.004
6" " " " 7 1/2"	0	.002	.000	+.005	.000	.001	.002	.005
7 1/2" " " " 9"	0	.002	.000	+.006	.000	.002	.002	.006
→ 9" " " " 11"	0	.002	.000	+.007	.000	.002	.003	.007
11" " " " 13"	0	.002	.000	+.008	.000	.002	.004	.008
13" " " " 15"	0	.002	.000	+.009	.000	.002	.005	.009
15" " " " 17"	0	.002	.000	+.010	.000	.002	.006	.010
17" " " " 19"	0	.002	.000	+.011	.000	.002	.007	.011
19" " " " 21"	0	.002	.000	+.012	.000	.002	.008	.012
21" " " " 24"	0	.003	.000	+.014	.000	.002	.009	.014
24" " " " 28"	0	.003	.000	+.016	.000	.002	.011	.016
32"	0	.003	.000	+.018	.000	.003	.012	

Figure 1 — This chart shows how easy it is to establish a shop standard for tolerances and allowances. Note that the allowances set up the degree of fit and the tolerances establish the accuracy required of the machinist.

female member 10.000 in. with a tolerance of plus 0.002 in. and minus 0.000 in.; male member 10.000 in. plus 0.007 in. allowance or a size of 10.007 in. with a tolerance of plus 0.000 in. and minus 0.002 in. On the drawing these sizes and tolerances can also be written 10.002 in. for the female member and 10.007 in. for the 10.000 10.005 male member, a procedure which has been adopted recently in our standard.

ESTABLISHING THE STANDARD

Aside from the distribution of the charts covering the seven fits, the task of instituting this standard is mostly a matter of education—education of shop superintendents, foremen, machinists, draftsmen and designers to the value and advantages to be derived from the use of tolerance and fit standards. In large jobbing and repair shops such as ours, it is sometimes difficult for shop men to see why a piece should be expensively remachined or salvaged simply because it does not fall within the specified tolerances. To machine the mating part to fit the off size would be so much cheaper and easier, and it is this attitude that will be found most difficult to overcome. However, the advantages are so obvious that even the most obdurate shopmen cannot fail to see them eventually. By making pieces to specified tolerances, spare parts may be carried on hand, expensive down time is held to a minimum, and a generally better quality product is attained than would otherwise be possible.

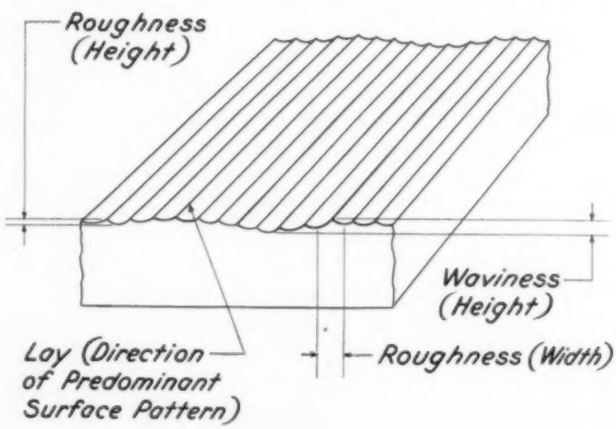
When it has been sold down the line that making pieces to specified tolerances produces more satisfactory products, and the machinists have been made aware that they must stay within drawing sizes, the next largest problem is the calibration of gages and measuring instruments. In the days when one machinist made both of the two mating parts, if he were required to make a ten-thousandth forced fit on a shaft he would simply measure the hole with an inside micrometer, measure the inside "mike" with an outside "mike," turn the outside diameter "mike" up ten thousandths and have his size. It did not matter if the micrometers read five inches or fifteen inches. Today, with one man making one part and perhaps some other shop making the other part, it is imperative that all micrometers read the same. Such a precaution is elementary and yet has been the cause of so many errors that considerable thought should be given to suitable procedures for continually checking and calibrating all measuring instruments and gages.

Of course the drafting room comes in for its share of indoctrination during the institution of such a standard. The largest point of contention is that the draftsman tends to keep the tolerances too small without giving due thought to the expense and difficulty the shop experiences in trying to meet the tolerances. Part of this tendency is the draftsman's desire to stay on the safe side, while part of it is lack of experience in setting tolerances. Naturally, with training and education, the draftsman will become more proficient; and his training will be greatly benefited if, when experiences in the field prove changes necessary, he is informed as to where, when, and why the tolerances he selected proved unsatisfactory. One of our plants has maintained closely this relationship between operating, maintenance and engineering departments to the mutual benefit of all concerned.

SURFACE FINISHES

Although committees have worked on it for years, it has only been since February, 1947, that a standard of surface finishes has been published by the ASA. In view of the length of time that was taken to crystallize ideas of standardization committees and in view of its so recent adoption, it is desirable to go into a more com-

Figure 2 — This sketch is used to define and differentiate roughness height, waviness, roughness width, and lay.



plete description of this standard before presenting the adaptation which makes up our corporation standard. From the many qualities of a surface such as color, lustre, hardness, corrosion resistance, etc., the ASA selected four qualities, (roughness, waviness, lay, and roughness width) as the most essential to standardization. The ASA definitions of these qualities are as follows:

Roughness: Relatively finely spaced surface irregularities. On surfaces produced by machine and abrasive operations, the irregularities produced by the cutting action of tool edges and abrasive grains, and by the feed of the machine tool are roughness. Roughness may be considered as being superposed on a "wavy" surface.

Waviness: The surface irregularities which are of greater spacing than the roughness. On machined surfaces such irregularities may result from machine or work deflections, vibrations, etc.

Lay: The direction of the predominant surface pattern.

Roughness width: The maximum permissible width of repetitive units of the dominant surface pattern.

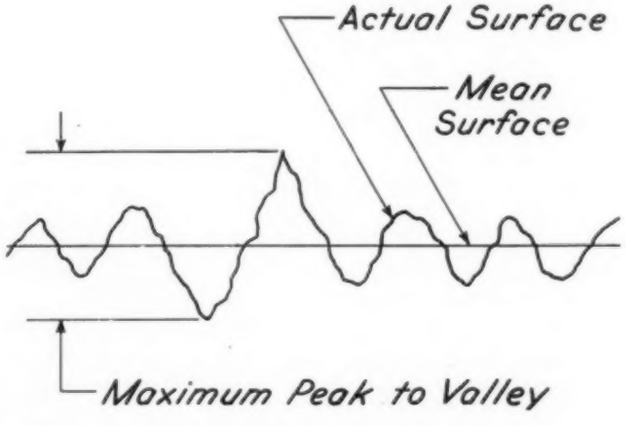
Figure 2 is a sketch similar to that shown in the ASA standard illustrating these qualities.

Without question, the most important of these characteristics is roughness, and for this reason it requires further amplification. There are two methods of evaluating, or measuring, surface roughness:

1. Instrument measurement of the surface with an instrument such as the profilometer or surface analyzer.
2. Visual and sensual comparison of the surface with finish samples of known roughness values.

The first method, measuring with instruments, is the only way of knowing exactly the degree of roughness of a surface since the second method can merely show whether a given surface is rougher or smoother than the given sample. By measuring the surface with an instrument, the actual height and depth of the peaks and valleys can be measured in millionths of an inch. Figure 3 is a magnified cross-sectional view of a typical surface and demonstrates the irregularity of surface roughness. It is obvious from this figure that, even with instrument measurement, evaluation of a surface is rather involved.

Figure 3 — This is an actual profile (magnified) which shows how irregular a machined surface may be.



This difficulty has led to three terms for expressing the results of instrument measurement: (1) maximum peak to valley height; (2) average peak to valley height; and (3) average—either root mean square or arithmetical—deviation from the mean surface. Of these three terms, the "Average Root Mean Square Deviation from the Mean Surface" is the one in most common usage. This term simply means that the micro-inch distance of each peak and valley from the mean surface is squared, these values summarized and averaged, and the square root taken of this average. Instruments such as the profilometer read directly the micro-inch value of the root mean square average. The ASA standard lists a total of thirty recommended roughness height values ranging from ¼ micro-inch up to 1000 micro-inches.

To complete the description of the ASA standards, seventeen waviness height values ranging from 0.00002 to 0.020 in. are recommended, along with six symbols indicating direction of lay. The four qualities are incorporated into a finish symbol consisting of a square root sign with definite positions for the value of each of the four qualities.

DEVELOPMENT OF OUR PLANT FINISH STANDARD

A considerable demand arose in our plant during the war for a standard of surface finishes. Not much could be done about it during the war, but upon its conclusion the demand increased and culminated in a plant finish standard. Before this plant standard could be put into actual practice, however, it was supplanted by a corporation finish standard which was approved and accepted by all the plants in our corporation. Consequently, the plant standard now to be described is not in effect and is only included in this paper because of the bearing it had upon the development and adoption of the corporation standard.

Like most jobbing shops handling only large work, our shops have a limited number of methods, machines and tools with which to produce any given surface. In fact, the number of surfaces that can be produced, that is from a utility standpoint, is very limited. Therefore, our first thought in developing a finish standard was to determine just what grades of finish our shops could economically produce. A standard containing a micro-inch value of 32 micro-inches, for example, would be of little value to us if we discovered that the tooling we would normally use for approximately such a finish would produce perhaps a 25 or 50 micro-inch value. On a small job, small increments of fineness may be obtained by changing the feed and speed, the grit of a grinding wheel, etc., but on a larger job, where certain specific tools are used for certain specific finishes, an increase in the smoothness of a spring-tool cut above normal can only be accomplished through superior workmanship, greater care, and considerably increased cost. In consequence, although it had the appearance of putting the cart before the horse, it was imperative to us to ascertain what micro-inch values (within a reasonable range) we would obtain from normal usage

of our tooling. Our types of tooling determined the number of finishes our standard would have since it is more economical to go to the next higher type of tooling, than it is to attempt to get a much finer than normal finish with a lower grade of tooling.

Although we do not wish, nor endeavor, to tie a specific finish to a specific producing method, our finishes are produced generally by the tooling of the following four groups:

1. Rough cutting to remove metal as fast as possible, done with a round-nose or carbide tool.
2. Clearance or appearance cut done with a square-nose, dragging round-nose, or fine carbide tool.
3. A fit cut done by spring-tooling or a very fine carbide tool.
4. A bearing cut done by polishing a spring-tool cut or by some type of grinding.

With these four groups of tooling we obtain micro-inch values of about 2,000, 250, 63, and 32, respectively. In order to cover the finer finishes that we can economically produce on small work in our small parts shops, we added one finer finish of 16 micro-inches to make a total of five finishes. These five finishes thus constituted our plant standard, a few outstanding features of which were: it considered only roughness height instead of the four qualities used by the ASA; the small number of finishes made the draftsman's selection of proper finish more certain and the shop's job of production easier; and finishes and tolerances were completely divorced from one another.

THE CORPORATION FINISH STANDARD

At the same time we were working on our finish standard other plants of our corporation were similarly engaged. Because of the general interest shown it was decided to develop a corporation standard which would be used by all the plants.

Several years ago the General Electric Company worked up a standard of ten surface finishes ranging from 4 micro-inches up to 2000 micro-inches, each value approximately doubling the previous value, thus: 4, 8, 16, 32, etc. Except for the 200 micro-inch value, all these values are listed in the ASA 1947 report so that this is, in effect, a selection of "preferred finishes" from the National Standard. In 1947 the standardization committee of the AISE endorsed this range of values by using them for the finish standard of the steel industry, AISE Standard No. 3, "Standards for Machined Surface Finishes," Iron and Steel Engineer, February, 1948. Since nothing that was done at any of our plants was in serious conflict with this system, and in an effort to be in conformity with the industry, we adopted this AISE Standard No. 3 as our corporation standard. The symbol used to designate the finishes, that of a letter enclosed in a triangle, did not find favor with most of our plants but was accepted in the light that a standard must be accepted completely or not at all.

With the adoption of the AISE standard as our corporation finish standard our plant standard lost its identity as such. Since the five finishes of this standard

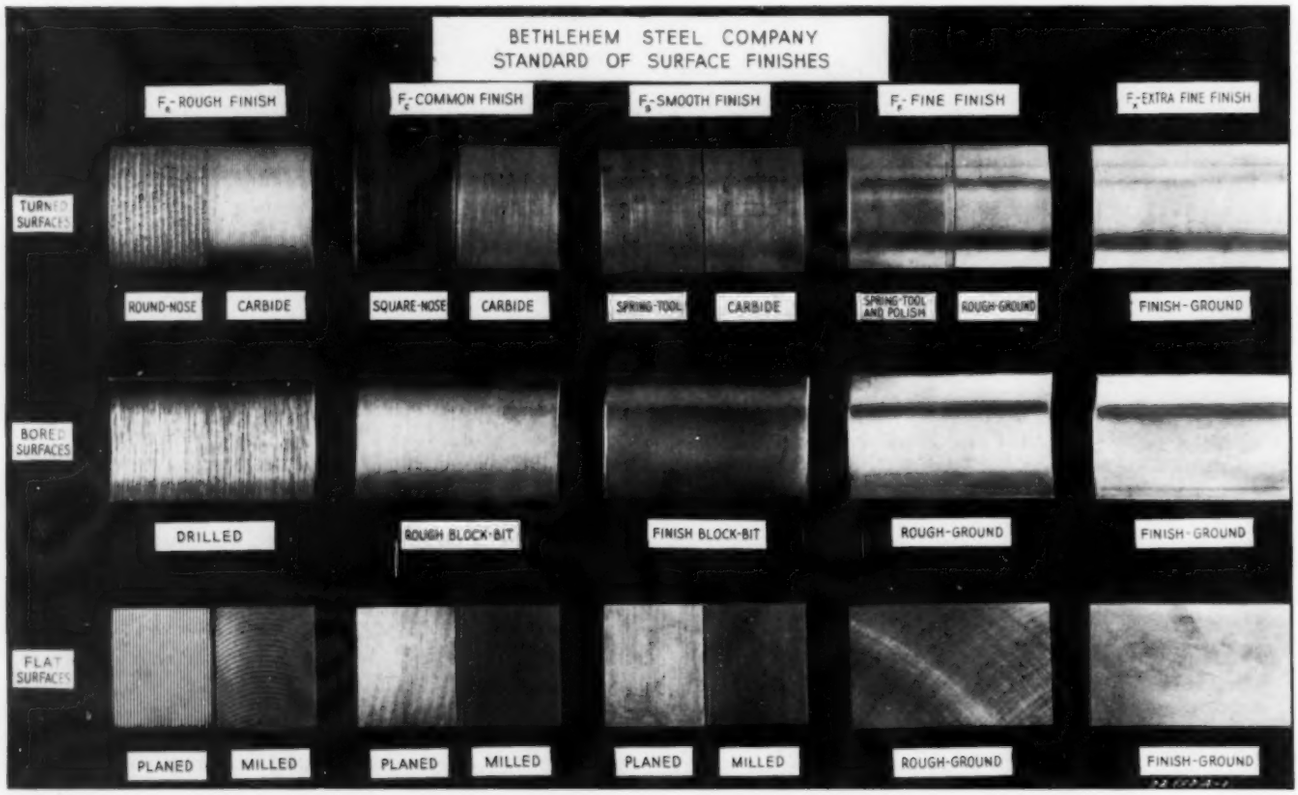


Figure 4 — In the Bethlehem Steel Company's standards of surface finishes, specimens have been made up, not only for flat surfaces, but for turned and bored surfaces.

were so basic, however, the corporation committee selected them as the "preferred finishes" in the corporation standard. The term "preferred finishes" is meant to convey that for ordinary service these finishes are the only ones to be used. This does not mean that the other five of the standard's ten finishes are useless; in the event that peculiarities of the work of one of the plants requires additional finishes or if a certain job requires special consideration, the necessary finishes will be taken from the remaining five. In this way the use of these "preferred finishes" enables the plants to retain the advantages of a small, simple standard and yet have the flexibility to cover new developments in tooling and products.

ESTABLISHING THE STANDARD

It had been our custom, in the past, to designate finishes on a drawing by notes, such as "rough finish," "smooth finish," "grind," "polish," etc. As anyone with such a system inevitably discovers, this method is a source of confusion, trouble, and needless expense, because the terms are ambiguous. Therefore, a method of surface evaluation was selected so that it would be primarily a means of communication between our draftsmen and machinists and, ultimately, a means of communication between plant and plant, and company and company.

As previously mentioned, there are two common methods of evaluating surfaces; by instrument measurement and by visual and sensual comparison. Although instrument measurement is the only finite evaluation, its major fault as a means of communication is its inability to be actually seen. For example, 63 micro-inches means nothing to a draftsman or machinist unless and until he actually sees a surface measuring 63 micro-inches. If this 63 micro-inch surface is not kept close at hand, the man will soon forget just exactly what constitutes the surface, and the value 63 will no longer have any meaning to him. Therefore, it was decided to use sensual and visual comparison as our method of surface evaluation. We plan, in our plant, to make up samples of our "preferred finishes," mount them on exhibit boards, and distribute these boards throughout our shops and drawing rooms. Figure 4 is a picture of a sample exhibition board which was made up during the evolution of our plant standard. Neither the headings nor the micro-inch values of the samples are correct, and the board is exhibited simply to show how our standard boards will be made up, the size of the samples, how they are machined, etc.

Quite a few companies manufacture sets of surface finish samples and the question naturally arises as to why we do not plan to use them. Several of our shops have used commercial sets for a number of years and have found the following points to be serious defects:

1. All existing sample sets are, to the best of our knowledge, made with single point tools. Many of our tools are broad-nose tools. Because different tools give a different feel for the same micro-inch value, we believe it essential that the sample be made with our type tooling in order to afford a good comparison.
2. All existing sample sets are made up in flat samples. Because we use different types of tooling on O.D.'s, bores and flats we again felt that better comparison could be made if we had samples of O.D.'s, bores, and flats in each grade of finish.
3. Our samples are 5 in. long by 3 in. wide, much larger than other sets, both in order to get a good representative comparison and also because with broad-nose tool feeds of $\frac{3}{4}$ in. and more, a sizeable sample must be made in order to show just a few cuts.

One more point of our standard needs mentioning. As noted before, the AISE standard which we have adopted, designates the various finishes by a letter inscribed in a triangle. One big objection to this system is not knowing what is meant by finish A, finish B, etc., unless one is familiar with the symbols. To overcome this defect we plan to incorporate in the title-block of our drawings a little chart giving the micro-inch value for each letter of the standard. This will be in a form similar to Figure 5, so that anyone will know exactly what our standard finishes are. It is our belief that this chart plus the exhibition boards will readily acquaint all concerned with our new standards and we anticipate their institution with little difficulty.

CONCLUSION

Many companies, as the need presses upon them, will be developing similar standards. Some will have no difficulty accepting the National Standards already set up; others like ourselves will feel the need for a more

Figure 5 — The sketch illustrates the symbols adopted in the AISE Standard No. 3 for specifying surface finishes on drawings. This standard was adopted by the Bethlehem Steel Company.

SURFACE FINISH STANDARD

SYMBOL	RMS MICRO-INCH VALUE	SYMBOL	RMS MICRO-INCH VALUE
A	4	F	125
B	8	G	250
C	16	H	500
D	32	J	1000
E	63	K	2000

specialized adaptation. But no matter how special a case a company may have, it should do its utmost to adapt its standards to the existing national standards. The use of preferred finishes permits the making of individual plant standards that are still in complete accord with national standards, and the more they are in accord, the more valuable and useful will these national standards become.

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DISCUSSION

PRESENTED BY

W. E. MATTHEWS, Supervisor of Shops, General Mechanical Department, Bethlehem Steel Company, Sparrows Point, Maryland

H. S. SPITZ, Chief Engineer, Phoenix-Apollo Steel Company, Phoenixville, Pennsylvania

F. C. SCHOEN, Engineer, The Midvale Company, Nicetown, Philadelphia, Pennsylvania

J. A. BELL, Chief Engineer, Bethlehem Steel Company, Bethlehem, Pennsylvania

L. F. COFFIN, Superintendent, Mechanical Department, Bethlehem Steel Company, Sparrows Point, Maryland

W. E. Matthews: We are in no disagreement with Mr. Harr as to the need of such standards in the steel industry to further efficient maintenance.

Fits and finishes have been of great interest to us for a long time, our interest being from a shop viewpoint and for economical reasons. When you walk into a machine shop office and see two or three foremen discussing a job and find that a good part of the discussion is devoted to the type of finish required for the job, and the amount of fit or play to be allowed, you realize the need of standards. You must realize that in a large steel plant there are thousands of jobs in process with several manufacturers' drawings in use at the same time, and none of these drawings show the degree of finish. A good many do not give fits and a still smaller number specify the tolerances. For instance, a certain manufacturer of steel plant equipment specifies the tonnage required for pressing on a gear, but he does not give the amount of fit. What happens when this drawing is given to the machine shop? The machine shop foreman makes a guess as to the amount to allow for the press fit, but seldom is his guess recorded; so the same procedure is repeated each time the gear is made.

As another example, a certain crane manufacturer will show a fit for a gear as 5 in. P.F., which means "press fit." If the works order calls for the manufacture of the gear only, what happens? The gear is forged and machined, leaving the bore small until the shaft is sent to the shop and stripped. Then the gear is set up and the bore finished to fit the shaft. Would not this country be in a fine shape if the automobile industry worked by such methods?

Speaking of finishes, it is rarely that we run into a drawing indicating the degree of finish, and when we do, no one understands the markings, because every company uses a different system. As stated by Mr. Harr, it was only in February, 1947, that a standard for surface roughness was approved by the American Standards Association. And it was in this same room, in 1939, that Mr. Gould gave a talk on this subject advocating adoption of such standards.

Of course, most manufacturers do not use the design drawings in their shops, but they use what is known as manufacturing drawings which give all pertinent information necessary for the mechanic to machine the job or piece. Seldom is this drawing furnished to the steel plant by manufacturers of equipment.

In other words Mr. Harr is advocating that a drawing be made, for the following reasons: first so that the mechanic can machine the piece correctly with the least amount of supervision; second, so the job can be inspected by a standard; third, so that responsibility for error can be definitely fixed; and fourth, so that the job can be carried out more economically.

With the acceptance of these standards the next problem is the actual application to the drawings. As stated by Mr. Harr, this is a matter of education. At the Sparrows Point plant of Bethlehem Steel Company we maintain a very receptive attitude to such standards, for the shop men and engineers are tired of being blamed for jobs that go wrong because the finish was not good enough, or the size was too close or too loose. Also, we are interested in putting the proper finish on the job for reasons of economy and serviceability.

In considering the importance of the type of finish, I might cite an incident that happened at Sparrows Point some months ago when one of the large manufacturers of tractors was on strike. One of the mills using a large number of these tractors was in dire need of propeller shafts which they could not get from the manufacturer, so they made an appeal to our shops to make some of the shafts. We agreed and made them from a heat-treated alloy steel to conform to a sample shaft. The shafts we made failed very quickly in the same manner as the original shafts made by the manufacturer. Upon investigation we found that our machining was the same as on the original shafts and the alloy as good, if not better. So what had happened? Upon close investigation, we noticed the shafts were starting to break through the tool marks. As the shafts were highly stressed and dimensions limited, we could not change the size, so a new group was made and ground in the

section where the breakage was occurring. These shafts gave considerably longer service than the originals and we understand the manufacturer is now following this practice.

In order to get such a program going, we have installed a machine where we can duplicate a drawing by the photographic process. We intend to mark-up the drawing with the proper finishes and fits, then photograph the section which covers the part on order. For example, if only a gear is ordered which will only require the space of an 8½ x 11 in. sheet, we will use a sheet of photographic paper that size and take off this gear. This will be economical for we will only issue to the mechanic a small-size drawing, convenient to handle. The original drawing is kept in the shop files and when it has been completely marked-up, we will return it to the engineering department for incorporating the changes on the original tracings. By this process there is little chance of error. Also, we do not have to mark up the full drawing for some of the parts may not be ordered for years, so that no time is wasted in marking up these parts.

New drawings coming out of the drawing room will carry the proper finish marks, fits and tolerances. In fact, most new drawings carry the fits and tolerances now; but not the new finish marks, because the standards have just been recently adopted.

Lack of information is the source of confusion. Fits, finishes and tolerances are as important as the shape of the piece. Both, unnecessary accuracy and insufficient accuracy will run away with the profits.

These standards insure interchangeability, proper inspection, proper planning, and proper application of incentives, so that production per man hour may be increased.

H. S. Spitz: How do you keep the finished samples from rusting?

W. E. Matthews: It is on a zinc plated material and it is, I think, tin plated on top of that. We have had them for some time. It shows no deterioration in the marking.

F. C. Schoen: I can agree with Mr. Matthews—it is going to save maintenance men a lot of work in assembling parts and fitting them together before he has to install them, and to avoid perhaps an extra 16 hours making a repair, sometime, if he can be assured that his fits coming out of the shop are proper. As to the balance of the paper, I would say we have a long way to go in most of our drawings.

J. A. Bell: With this system of tolerances I believe we can keep our drawings in such shape that the shop man will be able to obtain the desired fit, with greater degree of accuracy.

Mr. Matthews made a statement regarding the number of different systems of designating "machine finishes."I think he was referring to the various plants throughout the country. I do not think it makes very much difference how many systems you have, if only the shop in your own plant understands what you are trying to get across; and if they understand it, I do not think it makes much difference whether or not that system agrees with the system in use in some other plant or city.

If the system adopted does not work out, I hope we will be big enough to say, "This is not the best system and correct it." I have an idea we may run into a little trouble. The reason for this is the fact that a form of triangle is also used to designate welds, and in many cases we would have weld and finish designations in close proximity.

L. F. Coffin: The importance of establishing standards and of using these standards of fits, finishes and tolerances has increased immeasurably in the steel industry in the past fifteen years with the advent of high speed precision mills and equipment with their complement of roller bearings and other parts requiring accurate workmanship.

About a year ago, we had a 16-hour delay in our 56 in. hot strip mill, due to breaking of a line shaft on the furnace charging table. It was roller bearing equipped and had been in service without any interruption ever since the mill was installed in 1937. The gears and bearings were in excellent condition; which is to the credit of the roller bearing installations. We had a spare on hand which had been manufactured and purchased outside at the time the mill was built. We put this spare in place and it ran about 15 minutes and then froze tight. On examination we found the thrust bearing rotating hardened plate had galled on the shaft. The drawing showed that the manufacturer had specified "running fit." It had a running fit alright, if you ran it at about one revolution a minute, for we had turned it freely by hand but it would not run at the speeds at which it was called upon to rotate. The result was that we had a failure and a delay, entirely due to the fact that no tolerances had been specified on the original drawing. The man who fitted the shaft originally, since the spare was made in another plant from that in which the drawing was made, had no idea what running fit was required.

One of the significant things in this discussion is that the Association of Iron and Steel Engineers has adopted a standard which is an adaptation of the American Standard Association's standard, as you have been told. Several major steel companies have adopted this same standard.

It should be our mission to use this method and to bring pressure to bear upon the manufacturers of steel mill equipment, many of whose representatives are here to adopt this same standard. This will mean that the drawings which come into our plant will be marked in accordance with our own plant standard and the entire steel industry and the manufacturers of steel mill equipment also will benefit.

One problem in connection with this new standard is the matter of education. The manner and method of putting it into practice involves nothing more nor less than, cooperation. In most steel plants, naturally, the men who know the most about finish, are the machine shop foreman and the master mechanic. These are the men who now usually decide what that finish is to be. To bring the draftsman, machinist and millwright to a common understanding of these standards, instruction by a well versed practical man who will contact and train all concerned is a primary requisite. With such a set up, this phase of steel mill maintenance can progress.

STEEL PLANT

. . . . communication equipment for the steel and mining industries should be designed specifically for the rough usage which they will be subjected to in these industries . . .

▲ COMMUNICATION in industry, especially the steel mill industry, has been of such recent development that standardization of apparatus has not reached the same degree that other types of apparatus for the mills has reached, or for that matter the degree that communication in many other fields has attained. Just as it was realized long ago that a mill type motor was necessary to give satisfactory service in a mill, it is now being realized that mill type communication requires differently constructed apparatus to give satisfactory service in steel mills. Our company was one of the first to realize this and we have endeavored to design apparatus to meet the need rather than to attempt to adapt apparatus that is standard and perfectly satisfactory for another field and expect it to perform well in a mill. The extent to which we have been successful has in a large measure been the extent to which we have been able to find or make suitable components.

Speaker requirements—For instance a loudspeaker using a paper cone is satisfactory for home radio, and will ordinarily last many years. It lasts far too long in a juke box. However, if this same speaker were used in a mill where it is subjected to the high temperatures, smoke, and steam coming from rolling mills, it would probably warp and become useless in a short time. If it did not warp, the paper cone would disintegrate in some six months to a years time. Moreover, while your neighbor's radio sounds very loud, nevertheless such a speaker simply does not have enough efficiency and power handling capacity to be used in a noisy location. The amount of noise in a steel mill is remarkable, and scarcely realized by people who are accustomed to it. A 40-watt amplifier used in a church to reproduce chimes from phonograph records has ample power to be heard blocks away, but the same amplifier may be incapable of energizing speakers sufficiently to make conversation understandable for 50 feet in a mill.

Speaker ruggedness—Communication in mills had to wait until powerful, efficient horn type speakers were developed that were constructed in such a manner that dirt was excluded from the air gap traversed by the voice coil and made of material that would last. Exponential horns and modified exponential horns such as the Jensen-Hypex are not exactly new, but the evolution of such horns took considerable time to reach the degree of perfection that they have attained at the present time. The earlier horns had aluminum diaphragms and a long exponential trumpet to couple the air to the diaphragm. Aluminum diaphragms were fairly good, but aluminum fatigued in service and cracked after a time. It is possible also that corrosion sometimes took place. More recently, especially since the war, most driver units are equipped with phenolic diaphragms which are reputed to be immune to both fatigue and corrosion.

Iron dust—Another factor that is of especial interest to steel mill people is the structure of the horn itself. A double re-entrant horn accomplishes the same thing accoustically that a straight trumpet does, and also prevents magnetic dust from reaching the diaphragm. The particles of iron floating about in a steel mill are exceedingly fine and will pass through any screen. The strong magnetic field existing in and about the driver unit on a horn attracts these magnetic particles and in time a considerable amount would be pulled up against the diaphragm. In a double re-entrant horn, the air column is folded back upon itself, and on the way in to the diaphragm magnetic particles must first pass through a region where magnetic field exists, and this magnetic field causes steel particles to stick to the sides of the horn and as a consequence they can never reach the diaphragm. Of course a small amount of iron dust pulled against the diaphragm does no harm but an accumulation such as may take place over a long period of time will fill up the space the diaphragm moves back and forth in, and this cavity would need to be cleaned out to restore proper functioning of the horn.

This example illustrates the care that must be exercised in selecting components that will give satisfactory service in the mill. That is why you will see that the loudspeakers shown here are all made with double re-entrant horns. If you would disassemble one of our speakers you would also find a phenolic diaphragm in it. Experience with these speakers has been very good. We can pick out similar things in all other parts of the equipment. Some of these things we were fortunate enough to anticipate and other things we had to learn the hard way.

Accoustics—Accoustics also requires consideration. The essential requirements of a communication system is to carry one man's voice to another man's ear with sufficient volume and clearness so that the message will be easily understood. In the first place it must be loud enough to override the ambient noise. Secondly, the accoustics of the room must be taken in consideration so the echoes and reverberations do not interfere with clarity. The loudspeakers should be placed so that the man who receives the message is sure to receive the major part of the sound directly from the loudspeaker itself and not receive part of it on second bounce from some wall. Everyone has probably had occasion to observe sound in a building that is not properly designed accoustically, and noticed that echoes seriously interfere with understandability. Hard surfaces reflect sound, and this reflected sound arrives at the listener's ear a little later than does the original sound. This tends to drag out syllables and cause words to run together. A mill is large, and there are numerous flat hard surfaces scattered about. While one does not usually think of echoes, yet they do exist. For this reason it is generally

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COMMUNICATIONS

By W. P. PLACE
The Farmers Engineering & Manufacturing Company
Pittsburgh, Pennsylvania

not best to try to cover too large an area with a single speaker. Better results are usually achieved with more speakers located nearer to the people involved. In the third place, the frequency characteristic of the amplifier must be such that the important frequencies for intelligible reproduction of speech are present but the lower frequencies which consume a lot of power without contributing greatly to intelligibility are reduced. The frequency characteristic that is most nearly ideal is a subject that will bring out a debate between almost any two or more sound engineers. If the frequency characteristic is flat, that is, if the lower frequencies, say from 100 cycles and up are all amplified the same amount as the high frequencies, say up to 10,000 or 15,000 and the loudspeakers used are capable of reproducing all frequencies, the utmost in naturalness is achieved, but a great deal of power handling capacity is required. If the lower frequencies are reduced or eliminated the power required is reduced a great deal with little loss in intelligibility and with some loss of naturalness. This is because the bulk of the energy contained in the human voice is concentrated in a band of frequencies of about 200 cycles, but the frequencies contributing most greatly to intelligibility lie above 200 cycles.

Researches conducted during the war indicated that in talking from one noisy location to another where the microphone picks up noise as well as speech and the loudspeaker is located in a noisy spot where the listener hears noise as well as speech from the loudspeaker, the best frequency characteristic is one that is flat from 200 to 600 cycles. Other authorities have favored a rising frequency characteristic, that is, one in which the higher frequencies are accentuated more than the lower. This arrangement reduces the power requirement of the amplifier and gives a reproduction that is a bit on the high pitched side, but is quite easy to understand.

After some experimentation, we chose a frequency characteristic that is about midway between these two. The frequency characteristic of our amplifiers is such that very little of the lower frequencies is amplified, and increasing frequencies are amplified by increased amounts, about 6 or 7 decibels per octave, until 1000 cycles is reached. Then the amplifier treats all frequencies alike up to about 10,000, at which point the amplification is allowed to fall off. This characteristic has been found to give good efficiency and speech, while still a little on the high pitched side, sounds quite natural.

Ease of service—What has been pointed out in regard to the speaker also applies to other components of the system, such as microphones and amplifiers. A steel mill is a rough place, and equipment built for steel mills must be designed to take what comes. With proper proportioning of the parts with regard to the high ambient temperatures likely to be encountered and due consideration to dirt and moisture, it is entirely feasible to design equipment that is suitable. Our design engineers have been schooled to give due consideration to the maintenance man by first of all doing their utmost to make service unnecessary, and then by designing the equipment so that it is easy to service when service is required. As an example we feature plug-in amplifiers. If an amplifier should stop functioning, as it surely will sometime, the service man can restore service in a matter of minutes by removing the amplifier and replacing it with a spare. Moreover, he does not need to repair the amplifier on the location where it is used. He can carry it back to his shop and repair it at his own convenience.

Need for carrier—All the foregoing applies to the wired, or audio equipment. When locations are fixed and it is convenient to run wires from one location to another, it is best to use the simpler equipment. However, there are a number of places where it would be impractical to use wires. Communication between a fixed location and moving locations such as the cabs of cranes, ore bridges, between the pusher, the door machine and the hot car of a coke oven, and from the dispatcher to operators of mine locomotives are such examples. The power system is the only connecting link that could be used.

Power line carrier versus radio — Communicating with moving vehicles, such as cranes, ore bridges and trolley locomotives posed a number of new problems. In the first place we discarded radio partly because of the difficulty in obtaining permission from the FCC to use the air, and partly because the personnel responsible for servicing and adjusting such equipment must have at least a third grade commercial license. Last, but not least, the management would be held responsible for anything that is said over radio equipment. Another factor is that it is difficult to avoid blind spots with radio, especially in the high frequency bands which would probably be the only ones available. This is especially true in coal mines where radio has been tried and found to be ineffective beyond a few hundred feet.

Design considerations—We chose to develop apparatus which used the power line for both a source of energy and a transmission medium. This has the advantage that if one decides to talk with the operator of a crane, the only thing necessary is to place one unit

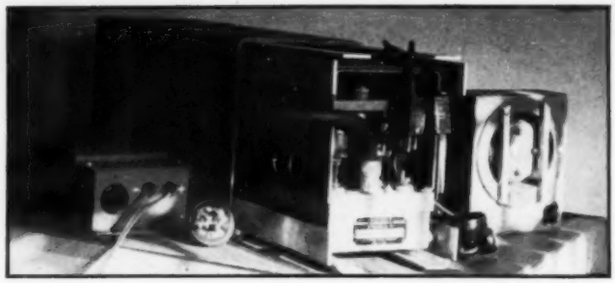
This is an example of a double re-entrant horn which has been designed to exclude as much dirt as possible from the diaphragm.

on the crane, another in the office, connect to the common 250 volt d-c power line, and go ahead and talk. In a sense this is not strictly new; power line carrier communication has been used for years by the large power companies, but we did face a few interesting problems. The most obvious of course are the sources of disturbance; such as the uncertain contact made by collector shoes, the disturbance caused by contactors popping in and out, and disturbance caused by the commutators of the motors. Less obvious but just as important is the variation of signal strength produced by various causes. Any load thrown on the power system affects the signal strength somewhat, and the load, as we all know, is continuously and abruptly changing.

Another consideration is that all receivers must be normally energized and all transmitters normally off. This is because if several parties are involved, no one transmitter can be left on or none of the others could come in. If then all receivers are on, some way must be found to silence the speakers during the time that no carrier is being received, otherwise the bursts of noise which would be coming in between conversations would soon have the operators crazy.

Reasons for frequency modulation—For these reasons we chose to use frequency modulation. FM has three advantages without which it is doubtful if successful communication over d-c power lines could be successful. One of course is that the signal to noise ratio for a given amount of transmitted power is considerably better than would be the case with amplitude modulation (but do not let anyone tell you FM is absolutely noise free). Another advantage is that an FM receiver can tolerate a sudden large change in the amount of received signal without distortion much better than an amplitude modulation receiver. Automatic volume controls can of course be used on amplitude modulation receivers, but an FM receiver inherently has instantaneous automatic volume control. This is because the last stage of the receiver which energizes the discriminator is normally operated in a saturated, or fully loaded condition on the weakest signal, and a stronger signal applied to the input to the receiver cannot drive it any higher. The incoming signal can vary suddenly through wide limits without making any change in the sound coming out of the loud speaker. We have arranged a switch so that we could suddenly change the amount of signal applied to the receiver by a ratio of 1000 to 1. With one person talking and operating the switch and the other person listening to the receiver, the listener could scarcely tell when the switch was operated. In performance this means that with FM a person using the equipment will not have his conversation disturbed by someone else operating a controller or by his own crane or ore bridge moving from one point to another.

Squelch circuit—The problem of a good squelch circuit required considerable design. Anyone who has stood near a crane or a coal mine locomotive and watched the sparks fly, can readily appreciate that there are times when the electrical disturbance is quite severe. Of course these disturbances are of the nature of pulses, and while their intensity is great, they are comparatively short lived. Hence the pulses if analyzed are found to have the characteristics of amplitude



The FM equipment shown has been specially designed for cranes and includes sturdy housing, rubber cushioning and plug connectors.

modulation chiefly; that is the amplitude of their energy is continually varying. They also have frequency modulation components, but in general the amplitude modulation components predominate by a considerable amount.

The problem resolves itself then in devising a circuit that can analyze what comes in to the receiver and determine whether it is predominantly amplitude modulated or whether it is predominantly frequency modulated. If the amplitude modulated components predominant, the circuit should interpret it as noise and prevent any sound from coming out of the speaker. If the frequency modulated components predominate the circuit should interpret it as signal and allow sound to come from the speaker. It must be borne in mind that this must be a device that can weigh the relative strengths of the signal and noise over a fairly wide range —a receiver should be able to work equally well in locations where the signal and the noise are both relatively strong as it does in locations where the signal and noise are both relatively weak. Whenever the signal is strong enough with respect to the noise to make intelligible conversation possible, the squelch should open, and whenever the noise is so strong with respect to the signal that conversation is impossible the speaker should be shut off.

The squelch circuit we developed combines a weighing device with two rectifier circuits. In one of these rectifier circuits, d-c voltage is developed in proportion to the amount of steady signal. An FM signal of course has steady amplitude and varying frequency. Hence the amount of steady signal is interpreted as useful carrier coming from another transmitter. The other rectifier circuit develops voltage in accordance to variations in the incoming signal. If there are sudden variations these are interpreted as electrical noise. They could also be considered amplitude modulated components, and as we pointed out earlier the noise can be considered as amplitude modulation.

These two voltages are balanced against each other, and the loudspeaker is energized or not depending on which one is the stronger. This is accomplished by regulating the bias on an amplifier tube following the discriminator. An amplifier tube can be prevented from amplifying by applying a high negative bias to the grid. Hence we have the interesting condition of one voltage trying to adjust the grid bias of this amplifier tube so that it will amplify, and the other voltage trying to adjust it so that it cannot amplify. Usually it is an un-

equal struggle however, as in a normal installation the carrier is considerably stronger than the noise.

Ruggedness—There are a few other things that needed to be worked out to insure that the unit would be sufficiently rugged both electrically and mechanically to give satisfactory service. Electrical ruggedness is achieved by choosing circuits and components of such a nature and of such a rating that they should last a long time without much adjustment or replacement. Mechanical ruggedness is achieved by anchoring all parts well, using rubber mountings that have equal resiliance in all directions, and enclosing the whole unit in a rugged steel case. This has proved satisfactory in practice. The units have been found easy to install and have been found to stand up and give good service once installed.

Oscillator stabilizer—Examples of electrical ruggedness are coils and condensers that do not change with age or temperature; and non-critical circuits that are not easily affected by variations in tubes, either normal variations of characteristics between tubes or variations in the characteristics if any tube through normal aging. For example, the frequency of the oscillator must be held within limits. It is of course possible to design vacuum tube oscillators that are quite stable with regards to frequency. However, the oscillator used in an FM transmitter is not one of these. It must be designed so that its frequency can be easily changed by the voice impulses applied to the microphone. Not only do voltages applied by the microphone influence its frequency, but it is influenced by other things, chiefly by variations in the characteristics of the reactance tube, caused either by variations of voltage or aging of the tube. We do not believe that crystal control is warranted because the circuit for a crystal controlled FM transmitter is complicated and we believe that for this type of service especially, the circuit should be kept as simple as possible on the general theory that the fewer the parts the fewer the sources of possible trouble, and moreover the simpler the circuit the easier it is to locate possible troubles and correct them.

However, something must be done to stabilize the oscillator, and what we did was to tie it into the discriminator of the receiver. The discriminator is a stable circuit. The voltage appearing at its output terminals is either plus or minus or zero, depending upon the frequency impressed upon it, and it is not influenced by line voltage or tube characteristics. Hence this is a good source for correcting influence. Voltage applied to the control grid of the reactance tube changes the oscillator frequency whether the voltage is a steady voltage or a fluctuating a-c voltage. It is only necessary then to connect the control grid of the reactance tube through a suitable filter to the discriminator of the receiver and arrange things so that the corrective d-c voltage as well as the a-c from the microphone are applied to the control grid simultaneously. If the average frequency tends to become high, positive d-c voltage is developed by the discriminator and as this is applied to the reactance tube, it drives the frequency back down again. If the frequency tends to become low, the negative d-c voltage drives it back up again. The net result is that the corrective action of the discriminator holds variations in the oscillator to less than $\frac{1}{10}$ of what they would be without it, and the only added circuit elements are one resistor and one condenser. Experience has proved that the oscillator stays on frequency quite well.

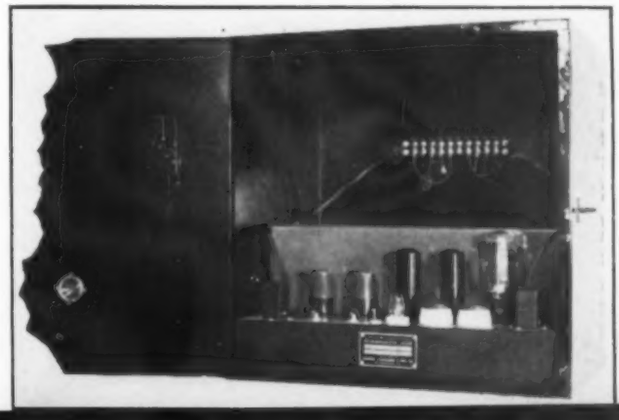
No relay—Another thing which contributes to both electrical and mechanical ruggedness is the elimination of a relay which might otherwise be used in the trans-receiver to change it from a receiver to a transmitter. Good relays are available, but the jarring that they would be subject to and the dirt that might get on the contacts and in the magnetic circuit would make the relay operate under unfavorable conditions. One contact on the microphone is used to shift the bias on some of the tubes to cause the transmitter to operate when the button is pressed and cause the transmitter to cease operation and the receiver to operate when the button is released. It is believed that static apparatus such as condensers and resistors are inherently more trouble free than moving parts such as relays, no matter how good the relay.

Mechanical design—Of course all parts of a device that is expected to stand up under rough usage must be well supported so that jolts and vibration do not overstress any part. All parts such as condensers, resistors and tubes are well supported and well anchored. While many of these parts may look small and delicate, it must be remembered that a part need not be large in order to be strong. It is all a matter of proportion. It might also be well to point out that the internal structures of present day tubes are surprisingly strong and rugged.

Shock mounting—The trans-receiver chassis is shock mounted on rubber cushions which have the same stiffness in all directions, but have the greatest freedom of movement in the lengthwise direction of the chassis. The chassis is slid into a protective case made of $\frac{3}{16}$ in. steel.

The whole assembly has been tested by dropping it two feet onto a solid cast iron block, and nothing was injured or even disturbed. This is equivalent to traveling $7\frac{1}{2}$ miles an hour and striking a solid obstruction. Perhaps some of this may look to be a little over-done. One can argue that it is not necessary to build a case that can be struck with a sledge hammer, but we must remember that this equipment was designed to fit a coal mine locomotive. Accidents do happen, such as rock falls and collisions, and we feel that the communication equipment should stand at least as much shock as the rest of the equipment the coal mine people regularly use.

This 20-watt audio amplifier has a large tightly closed cabinet and plug connectors.



Steel Foundry
PRACTICE AND MAINTENANCE

. . . . this paper was presented in conjunction with an inspection trip by the AISE Buffalo District Section through the foundry of the Pratt & Letchworth Company, Buffalo, New York . . . .

By FRANCIS J. MACANO
Assistant Metallurgist
Pratt & Letchworth Co., Inc.
Buffalo, New York

FOUNDRY PRACTICE — PART I

▲ STEEL castings are poured into three types of sand molds, the selection of which depends on the size of the casting, the thickness of sections in the casting to be poured, the number of pieces required by the customer, the surface condition specified by the customer, whether areas of the casting are to be machines and many other factors.

The first and probably the most popular method of molding is the green-sand practice. Many small castings which require little or no machining are made by this method. In this type of molding, sand is rammed over a pattern, stripped, finished and then poured without further treatment of the mold cavity surface. The green-sand method proves itself very satisfactory in a shop which has highly repetitive type of work because there is no delay between the making of the mold and the pouring of metal into that mold. However, this method requires very close supervision and control because there can be a lot of trouble if sand is not properly prepared.

The second basic type of molding is the skin-dried method. This method is used when making molds which require added protection from the erosion of metal on mold cavity surfaces, when making castings which require fairly smooth surface, and also castings which have thick sections. In this method of molding, sand is rammed over a pattern and after stripping, the mold cavity surface is sprayed with a mold wash made up principally of silica flour, water and a commercial mold wash, and then dried with a gasoline torch to a depth of about one inch. The mold is then finished, closed and poured.

The third type of molding is the dry sand method. In this type of molding the sand is rammed over a pattern and after stripping, the entire mold is placed into a large oven and thoroughly dried at temperatures of about 500 F. The dry-sand molding practice is used when making large heavy castings which require much more protection than is provided by skin drying.

We use all these three methods of molding. When an order for castings is received, it is the responsibility of our foundrymen to study very carefully the design and particular requirements before a decision is reached on which type of molding is to be used in making the casting.

There is a wide variety of methods for ramming up molds used in foundries. Each method has its advantages for the specific type of casting being manufactured. The oldest and probably the crudest is hand-ramming. This consists of pounding small quantities of sand into areas of the mold with a wooden mallet or with an air rammer. The sand is built up in layers and pounded into shape. This method is very inexpensive but has many serious disadvantages. In the first place it puts a great deal of responsibility on the operator, because if he does not ram all areas uniformly, the mold will be too hard in some areas and too soft in others, thereby causing casting defects such as scabs, blows and swells.

The next method of ramming is the jolt-rammer. This method consists of filling a flask with sand and then by means of a hydraulic piston allowing the pattern plate and flask to rise and fall a given number of times. The impact imparted to the flask on the fall causes the loose sand in the flask to become closely packed. This method is very successful because it gives the mold a uniform hardness. It is very widely used because it is fast and efficient.

Another method of ramming molds is the squeezer, in which a pressure is placed on the top side of the flask pushing the sand toward the pattern in a downward direction. The squeeze method is used in our plant in conjunction with the jolt method. The flask is filled with sand, jolted and then squeezed. This method has proven very successful in making small castings which do not require flasks more than 10 in. deep.

Probably the most interesting method of ramming molds is the sand slinger. Here we have a mechanical device which throws sand into a flask at very high velocities. The sand drops from a hopper to a belt parallel to the floor and then into a small cup which is being rotated at high speed. As the sand travels in a semicircle to an opening in the bottom of the slinger head, it is pushed into the flask and packs itself. The great advantage of the sand slinger over the other methods of mold ramming is its great flexibility. It can be used for very large molds or small ones without any changes in

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equipment. On jolting machines, only one size flask can be made without changing plates, while with a sand-slinger loose patterns can be used thereby saving many dollars for customers who do not need certain patterns in any great quantity. Another advantage in using the sand-slinger is that all molds are rammed uniformly regardless of longitudinal size or depth.

Now that we have covered the types of sand molds and the means by which they are made, let us discuss the core room. A core is a mass of sand made to a definite size and shape and is used to make inner cavities in steel castings. Cores are formed in core boxes of metal or wood containing a cavity the shape of the desired core. The core box is filled with sand and after ramming, the core box is removed and the core placed on a plate. The plate supports the core so that it can be moved and baked. Many cores, particularly cylindrical ones, require metal assemblies which have the same contour as the core so that they will support the core and eliminate distortion during the baking process. Large cores are further strengthened by the use of rods, pipes, arbors and wires. Whenever necessary, core chills and chill nails are placed into the core during the ramming period and they are securely held in place during baking.

The various methods used in ramming cores are, hand ramming, air rammer, jolting machines and by blowing.

The hand ramming method consists of filling a core box with sand and then ramming it with a wooden mallet. When the core box is deep and a large core is being made, the ramming is accomplished by the use of an air rammer to insure uniform hardness throughout the core. The jolting method in core making is very similar to the jolting method we discussed in mold making, that is, a core box is filled with sand and then is allowed to bump up and down until the sand is packed solid into the core box. The last and by far the most interesting method of making cores is the core blower. The core blower is a mechanical device which delivers a mixture of sand, binder (dry or liquid) and containing a certain percentage of moisture into a core box in such a way that as the sand mixture is deposited into the core box it is blown hard enough so that the core is ready for drying and subsequent use in a mold without any further mechanical working.

In blowing a core, the core box is filled by allowing sand suspended in a stream of air to enter the upper end of the core box cavity at high pressures. As the stream of air and sand enters the box, the sand grains pile up against themselves while the air stream passes from the core box through properly arranged vents. The air must be completely exhausted through the vents or there will develop certain areas which will be soft because of the trapping of a mixture of sand and air in any part of the core box cavity. Cores made from properly constructed and vented core boxes by blowing machines are more uniform in hardness because the sand is delivered to all parts of the core box with equal force and thus eliminates the possibilities of hard and soft spots which so often develop in rammed and jolted cores.

Core boxes for blowers are made of aluminum or magnesium and all parts of core boxes which are subjected to excessive wear are protected with inserts made of hardened steel and so constructed that they can be removed and replaced with new inserts. Parting lines are faced with $\frac{1}{8}$ in. thick strips of hardened steel in order to prevent excessive wear at those areas.

After ramming, cores are placed on racks and then into core ovens where they are baked at about 450 F for periods of time depending on the type of binder used and the size of the core. The primary reason for baking cores is to facilitate handling because cores become harder and stronger than they were in the green state. Many cores are used green whenever possible because of the saving in binder handling, baking, etc.

After baking the cores must be subjected to a series of operations before they can be used in a mold. First they must be trimmed of excess sand such as fine resulting from worn loose pieces in core boxes, humps or high spots caused by worn spots in the core box. The trimming is usually accomplished by filing or by rubbing. The next process is the application of a core wash by brushing, dipping or spraying. The material used to wash cores is essentially the same as the one used to wash molds. The difference between cores and molds in respect to surface coating or washing is that the cores after washing are again placed into drying ovens to drive off the moisture from the wash while the molds are dried with gasoline torches. Many cores because of

Figure 1 — The sand slinger shown is used for ramming molds. It has the feature that it can be used for both large and small molds without any changes in equipment.

Figure 2 — The core blower is a device which delivers the mixture of sand and binder hard enough so that the core is ready for drying and subsequent use without any further mechanical working.

Figure 3 — Core blowers are also made in large sizes.

their shape cannot be made in one piece, therefore the core is made in halves. After baking and trimming the two halves are put together or pasted. After being thoroughly inspected the cores are transported from the core room to suitable stations behind the molding units.

Up to this point we have covered the molding practice and the core room procedure in a modern steel foundry. Now it is proper that we discuss briefly the type of sand used, the process of mixing, molding and core sands and the reclaiming of sand for repetitive use.

The base sand used is Ottawa washed and dried silica sand having an American Foundryman's Association Grain Fineness Number from 30 to 35 and is A.F.A. Grade No. 7. We have a battery of 3 sand mullers with a capacity of 2000 pounds in which we process molding sand and we also have a 1000 pound muller in our core room used only for processing core sand mixes.

Basically the process of mixing sand is as follows: A predetermined weight of sand and dry binder is placed in the muller and milled dry for four minutes, then the liquid ingredients such as core oil, plain water or molasses water are added, and the mixture allowed to mill four minutes more. The sand is then ready for use in a molding unit or on a core maker's bench.

SAND RECLAMATION

After a mold has been rammed and all cores have been put into their proper places, the mold is closed, that is the cope or top is placed on the drag or bottom and both flasks are clamped together and the mold is pushed down a roller conveyor line ready for pouring. Molten metal at temperatures of 2800 to 3000 F is poured into the sand molds and allowed to set for a period of time before the castings are shaken out. In the shake-out process, the flasks are placed over a vibrating perforated plate which loosens the sand and cores from the casting and flasks. The loosened sand and the pieces of cores are allowed to drop through the perforations in the plate on a conveyor which takes them to the reclamation system. Molding sand in the modern foundry is reused repeatedly with the addition of controlled amounts of fire clay and cereal binder; therefore a reclamation system is a must. There are two fundamental types of sand reclamation systems in common usage in foundries. The first is the wet method in which water is used to remove fines, broken sand grains and burned out binder. The second method and the one we use is the dry method which uses screens and suction to remove fines. Basically, the dry method of sand reclamation is a screening operation with exhaust suction to remove extremely fine silica, clay and fine particles of broken sand crystals.

After the shake-out operation, the sand conveyor takes the material from the flasks to a breaker screen where soft lumps are broken up. The sand which passes through the breaker screen is moved by belt to a magnetic pulley which removed tramp iron, wire and other metallic particles. The hard lumps from the molding sand and parts of cores are put through a core crusher and then elevated to a hummer screen which eliminates the fines by air suction and screening. This sand is then placed into storage bins for reuse. We have found that sand from the shake-out contains under 2 per cent of fines retained on a 100 mesh sieve. This sand can be used with satisfactory results in making molding sand.

Figure 4 — Shown in this photograph is the clamp on a large core blower.

however it must be processed further for use in our core room. This further treatment consists of dry milling for four minutes and the screening. After screening we find as little as 0.5 per cent retained on a 100 mesh screen. The screened sand is used in conjunction with new washed and dried silica sand in our core room.

Throughout the whole process of making a mold and the cores necessary for making a steel casting, the sand and the cores and mold are subjected to various tests to insure uniformity of product. The purchased new sand is given a sieve test to determine the percentage of fines and also to insure conformation to specifications. After milling the sand mixes are checked for permeability or the ability of the sand to allow air and gas to pass through, green bond or the ability of the sand to retain its shape after molded, and most important of all, the moisture content of all mixes is accurately measured and carefully maintained at a percentage which is best for each type of mix. Every new core mix is tested for tensile strength to determine its hardness after baking. The cavity surface of molds is periodically checked for hardness to insure proper ramming because we know that molds can be rammed too hard causing blows and uneven surfaces on the castings or too soft causing sand to be loosened by the flow of metal on the mold surface and having sand penetrating into the casting surface. The mold and core washes are mixed according to standard procedure and the specific gravity of each batch is checked to insure uniformity. Core baking ovens are equipped with automatic controls and recorders which keep temperatures as uniform as possible and therefore insure uniformity of baking. Cores are checked for surface hardness both in the green and baked condition so as to guarantee uniformity. Periodic samples are taken from all sand used and standard sieve tests are run to determine fineness and residual clay content.

Figure 5 — Sand mullers are used in the core room for processing sand mixes.

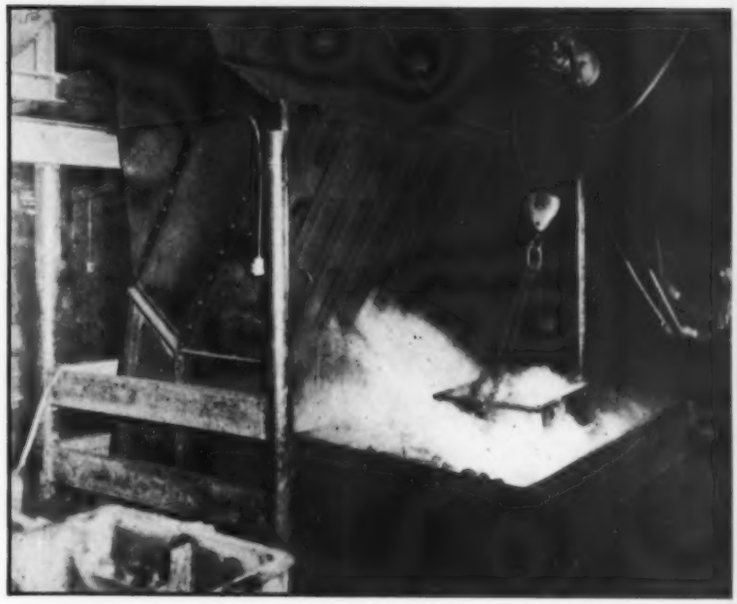


Figure 6 — The shakeout unit loosens the sand and cores from the castings and flasks.

PLANT HOUSEKEEPING — PART II

It is our intention to give the same attention to safety and housekeeping that we do to production, in the belief that production and safety should go hand in hand.

For years we have had a definite housekeeping program which has been changed slightly from time to time due to experience.

In addition to attention given this subject by departmental supervision, monthly inspections are carried on covering both safety and housekeeping. The Inspection Committee is composed of two representatives from management and two appointed by the union. In addition, the safety engineer is chairman of the committee and a permanent member.

Each member of the committee serves two months. The rotation is such that each month one labor representative and one management member are dropped and two new members come on. In this way, considerable number of employees have participated as members of the committee. On the inspection made during his second month, a member can observe what has been accomplished as a result of the previous month's inspection and can give due credit for improvement.

Date and time of inspection is set by the safety office and members of the committee are advised late in the afternoon of the day preceding the inspection in order to avoid the possibility of one department having the

Figure 7 — The high hat is the award given to the department which is judged to be the cleanest.

advantage of knowing about the inspection and preparing for it at the last minute.

The committee meets in the safety department where a brief outline is given as to procedure, and each member is supplied with a looseleaf book in which to make notes.

Tour is made of the plant, after which the committee returns to the safety department and each member indicates on a form provided, the percentage rating for each department according to his judgment. Members of the committee rate all departments excepting their own. The average ratings of the committee for each department are then arranged in order according to the highest percentage down to the lowest percentage.

The department receiving the highest percentage is awarded the high hat, our symbol of the highest rating. A sign is also prepared on a 24 by 36 inch poster which reads as follows:

Maintenance

After completing a tour of the plant today, it is the opinion of this committee that the above department was in the best order.
(Signed by each member of the committee)

This notice and the high hat are placed on an easel and exhibited in the department for a period of one week.

The department having the lowest percentage is awarded the brown derby. This derby and a permanent sign are placed in the department on an easel at the most disorderly location that is directed by the committee. The sign on this easel reads as follows:

Order

A place is in order when there are no unnecessary things about and when the necessary things are in their proper place. NO in this instance means NONE, NOT EVEN ONE.

(Signed—P. & L., Inc.)

I might add that the idea of the brown derby and high hat were proposed by the foremen many years ago and excite friendly rivalry in promoting our housekeeping program. You can be sure that the department getting the brown derby one month will correct their mistakes and show a great improvement the following month.

At the meeting in the safety department after the plant tour, all slips containing notes of items of interest

Figure 8 — The brown derby is given to the most disorderly department. It is only natural that each department attempts to get rid of this award as soon as it can.

ORDER
A place is in order when there
are no unnecessary things about
and when the necessary things
are in their proper places.
NO in this instance means NONE
not even one.

noted by each committeeman during the plant tour, are turned over to the safety engineer who reviews them while the full committee is present, after which they are transcribed on to individual department reports and placed in a folder. Each department head visits the safety office sometime within the following week and takes notes of items pertaining to his department so that where it is possible the necessary corrections or improvements can be made in advance of the next inspection.

Standings are posted in a framed bulletin in the main time control office for review of all employees. At intervals, standings are sent weekly to the homes of employees in our weekly "Bulletin" and on occasion, are in our monthly magazine "Castings," which also is mailed to homes of employees.

DISCUSSION

PRESENTED BY

A. F. WOLF, Simonds Saw & Steel Company, Lockport, New York

F. J. MACANO, Assistant Metallurgist, Pratt & Letchworth Company, Inc., Buffalo, New York

K. E. McHENRY, Assistant to Superintendent, Mechanical Department, Bethlehem Steel Company, Lackawanna, New York

H. R. TURNER, Superintendent Mechanical Department, Bethlehem Steel Company, Lackawanna, New York

J. H. JANSSEN, Wickwire-Spencer Steel Division, Colorado Fuel and Iron Corporation, Buffalo, New York

H. H. NORTHRUP, Superintendent, Open Hearth Department, Republic Steel Corporation, Buffalo, New York

D. L. BOYES, Plant Manager, Central Foundry Division, General Motors Corporation, Lockport, New York

A. F. Wolf: In your method of sand reclamation do you remove all the clay or do you make allowances for it in future use?

F. J. Macano: We do make allowances for it in future use. In other words, we would add much more clay to our new sand than our reclaimed sand. In fact, we expect a return of six per cent clay in our reclaimed sand.

A. F. Wolf: What method do you use for determining clay content of sand?

F. J. Macano: We use the standard A.F.A. method of flotation, with Dietert equipment, with a mixture of sodium dioxide and water. The sand is stirred and allowed to settle until we know all clay particles which will float have been removed. We find we have about six per cent, on an average, of clay retained in our reclaimed sand and we do compensate for that by the addition of less clay to our bins.

K. E. McHenry: Do you use the same sand for back-up sand and facing sand?

F. J. Macano: We use the same sand. We use molding sand in small flasks where it is impractical to use back-up sand but in very large molds in our pits we do use what we call "heap" sand for backing up. On our floor molds we use all base sand of 30-50 A.F.A. fineness, or Class 7.

K. E. McHenry: Do you change it in lighter castings to a finer grade?

F. J. Macano: We do not change it in lighter castings. We do use No. 4 class sand for making certain types of cores. In our molding sand we use only the No. 7.

H. R. Turner: I could not help but note the many aspects of foundry practice in evidence as exemplified by a production foundry in comparison with a jobbing foundry that is operated purely for maintenance such as we have in steel plant work. First of all, the thing that struck me was the metal flasks and the many metal patterns that were in evidence. Most of ours are made of wood. The second thing that struck me, which Mr. Macano covered very expertly, was the good housekeeping in the foundry; the use of material handling equipment, the planned flow of the materials, the mechanical means for molding, shake-out, sand reclamation and so forth. After seeing all this equipment in operation the thought struck me, "Where do the economics come into the picture? Where is it practical to use jolt and squeeze molding and all of these various mechanized units for molding?" I mean how many pieces are required to make it economical to use this equipment? Referring to the core operation, I can visualize in a jobbing foundry with various types of castings to make and only a few of each type, that the equipment required to utilize this system in foundry practice would entail rather extensive ramifications. Another thing that interested me very keenly was the absence of sand all over the place. The sand reclamation features are very interesting. The lack of dust in the shake-out operation is interesting.

One question I would like to ask on sand reclamation, with the amount of equipment available in the foundry, no doubt the orders for new sand and the amount of new sand mixed must be very low. What is the figure ratio on new sand and old sand?

F. J. Macano: I can give you the figure for new sand which, of course, is bound to fluctuate. We have the problem of the jobbing shop because we do jobbing work, where we have one or two of a kind to make and there, as you noticed, we do not use any of the mechanical units which we use on our molding floor. We are in that field, a highly repetitive foundry, that is, we have standing orders for unlimited quantities of the same type of casting. If you do not have that type of order, you cannot possibly use the type of facilities we have.

The core blower is very ideal but when you figure the cost of a core box for making just one core it is highly prohibitive for the jobbing shop. However, in our particular case where we make hundreds of molds per day of one particular type it is a different situation. Incidentally, we not only blow the body cores for some of these jobs but we also blow the sprues and the pouring cups. That, in a jobbing foundry, would be quite economical. And our new sand consumption I say, on an average, would run approximately 450 pounds per ton of good castings produced which is quite low.

H. R. Turner: As we progressed through the foundry, another thing of very great interest was your sand

slinger. I noticed it is your practice to use it on relatively shallow flasks. How practical is it for ramming molds where you have a very deep mold with a small area in which to put the sand? When I say "deep" I mean something in the nature of 90 inches high.

F. J. Macano: It can be used. We use it on a variety of very large and very small molds.

H. R. Turner: When it is used in anything as deep as I mentioned, do you get a uniform consistency in your ram?

F. J. Macano: Ninety inches is quite a bit, and I do not think we have gone to anything that high. I believe that is beyond the limitation of our present installation. I do know of shops that use it under tremendous depths and the flexibility of a sand slinger is such that you do not need to worry about the depth of a flask. As you go along with an expert operator remember that he has to be able to distribute sand evenly throughout his flask. The depth or longitudinal dimensions mean nothing for there again you have to depend on the operator. If he has a flask ten by twenty he may ram one side of it only and not distribute his sand evenly throughout the whole area. It is like drying concrete and trying to get one layer dry before you dry the other and it is going to be lop-sided. If the sand from a sand-slinger is put in evenly it will be evenly rammed but it is a training program for the operator of your sand-slinger.

H. R. Turner: Another feature I was interested in is the core ovens for your large molds. As far as I can see you use ovens with a very fine temperature control and indirect heating. Is that right?

F. J. Macano: It is indirect heating. We have ducts which conduct the heat into the oven and we have a way of adjusting the louvers on our ovens. By controlling the louvers we find we can get very even distribution of heat but there may still be hot spots in that oven. There again it is a matter of control of the air coming into the drying ovens.

H. R. Turner: In connection with sand mixing, old sand is reclaimed and used over and over. Is all your mixing done and your synthetic binders injected in the molding machine?

F. J. Macano: Yes. In the case of the foundry mills we have hoppers over the top of the mills which have an exact amount of sand. If we want a one ton mixture we put in a certain number of pounds of sand, which plus the dry binders gives us a ton. That amount of sand is milled dry to insure breaking up of the lumps and the loosening up of whatever loose binder is on the sand grains. We add our dry ingredients and then mill it four minutes. We add liquid ingredients, oil, water and so forth and they are further milled four minutes to insure proper tempering of the sand mix.

J. H. Janssen: I would like to know how you keep the different sand mixes separated?

F. J. Macano: Our green sand molds are made on our conveyors, that is, on our pumping units and our dry sand and skin dry molds are not made there. They are made either in the pit or on the slinger floor and when we do have skin dried or dry sand molds we either allow that sand to go through the system to the particular unit which is using it or we put it in boxes; boxes containing about two tons of sand. In other words, we can get about two mill batches into a box and then the sand is shoveled from the box into the flask that is going to be used as skin dry or sand dried mold.

J. H. Janssen: I had a little experience in a foundry during the war. We had quite a bit of trouble getting some of the sands mixed up and we colored it in order to be sure we did not get it mixed in the wrong process.

J. H. Janssen: What test do you use for hardenability?

F. J. Macano: Right now we are using the Grossman formula with a very good result. In fact we are calculating the quenching time and the draw time from strictly a chemical composition basis. We have a regular chart made up and we can calculate almost instantly whether those are high, low or medium, but during the war we did use the Jominy end quench test.

J. H. Janssen: We also used the Jominy test. We ended up with a time quench. It was determined by the weight of the castings and the draw was calculated and figured from hardenability, from the Grossman formula.

H. H. Northrup: Has casting temperature of the steel any effect on core or surface conditions on the finished casting and if so, do you have any method of controlling this variable?

F. J. Macano: We do know there are certain types of castings we cannot pour when we first open the ladle, so therefore, we do not pour those until maybe the last third of the heat in the ladle. We do know we get better results if we pour them at a low temperature but what the correlation is I cannot tell you, but we do segregate certain castings and pour them at certain times of the heat.

D. L. Boyes: With sand 30-35 A.F.A. fineness, how do you manage to avoid penetration of the iron into the sand?

F. J. Macano: On certain castings we do not pay attention to it for it is not vital. However, on castings where surface finish is vital we wash it. We find it is easier to use a conventional mold wash than to try and have two or three different types of sand and, after having gone through our plant, you would see what a mess we would be in if we had to be able to segregate a sand down around 80 or 90 and have another job which requires 80 or 100. We use corn binders to a great extent and some fire clay with moisture about four to five per cent. We try to keep it as close to four and one-half as we can and we try to control it at that point by the addition of measured amounts of water, also we gage the temperature of our sand and also atmospheric conditions. On some days, our sand is a little bit wetter. We gage that and put in less water.

D. L. Boyes: With your sand reclamation how about using half new sand and half reclaimed sand in making cores?

F. J. Macano: In certain instances, yes. In other instances we require 100 per cent new sand. In certain instances we use reclaimed sand, sometimes one-half and sometimes one-third.

D. L. Boyes: Then you can mix the same sand and get the same moisture content and final core by using either all new or reclaimed sand?

F. J. Macano: Yes, we try to maintain approximately the same moisture in all. If we have a core mix that works best at six per cent we will try to maintain the six per cent moisture regardless of what type sand we add.

OFF-SITE BLAST FURNACE CONSTRUCTION

▲ THE talents of the moving man on a large scale have been applied in the development of a new technique of off-site blast furnace construction. In this case the "moving man" is a Pittsburgh construction firm, the Eichleay Corporation, specialists in moving buildings and heavy industrial equipment. As a result of one of its recent jobs, a blast furnace at Indiana Harbor is producing critically needed pig iron an estimated two months ahead of conventional schedule.

The Youngstown Sheet and Tube Company used the off-site erection and moving technique in the replacement of its No. 1 blast furnace at the Indiana Harbor plant. The original furnace, 30 years old and with a daily capacity of 800 tons, was taken off blast June 12th. After the old furnace was dismantled and new foundations had been prepared, the pre-built shell of a new and larger furnace was moved 131 feet to the same site. The replacement furnace began its daily production of 1400 tons of pig metal on September 17, just 95 days after the old furnace was blown out.

The reduction of "down time" salvaged the production of many thousand tons of pig iron, and of resultant steel products, at a time when there is a critical demand for every available pound of metal goods.

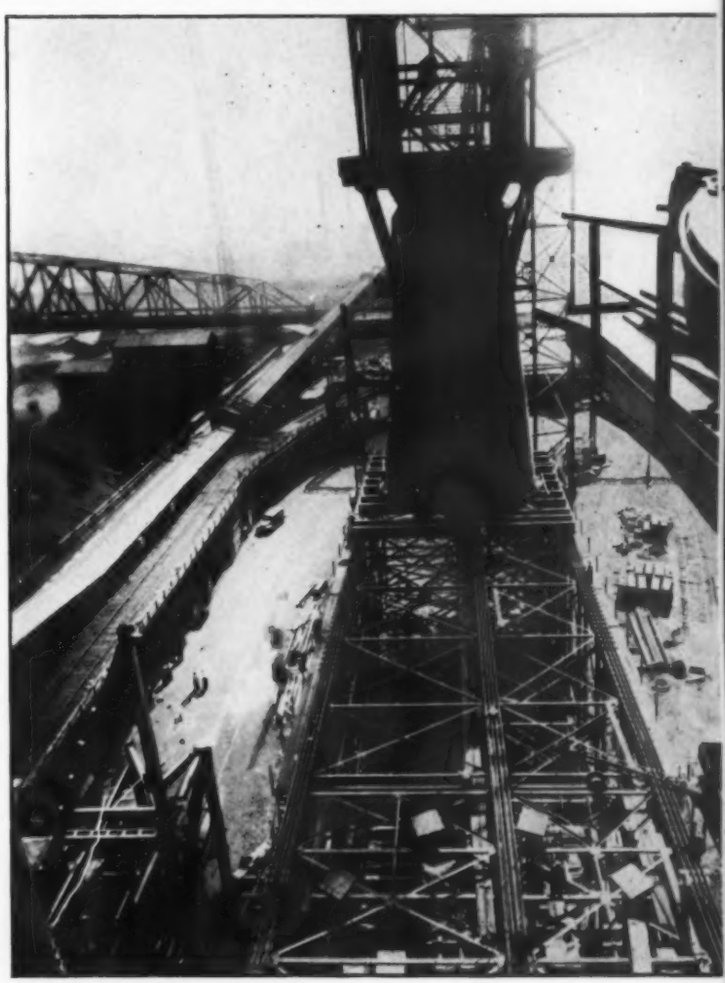
The key to successful time saving in this type of construction rests in precise planning and careful integration of all steps in the project. Through careful planning, the Youngstown Sheet and Tube Company arranged to have a number of auxiliaries, as well as the furnace shell, built while the old furnace was still in blast. Among the units so built ahead of schedule were one of the three stoves, the dust catcher and precipitator, and the washer.

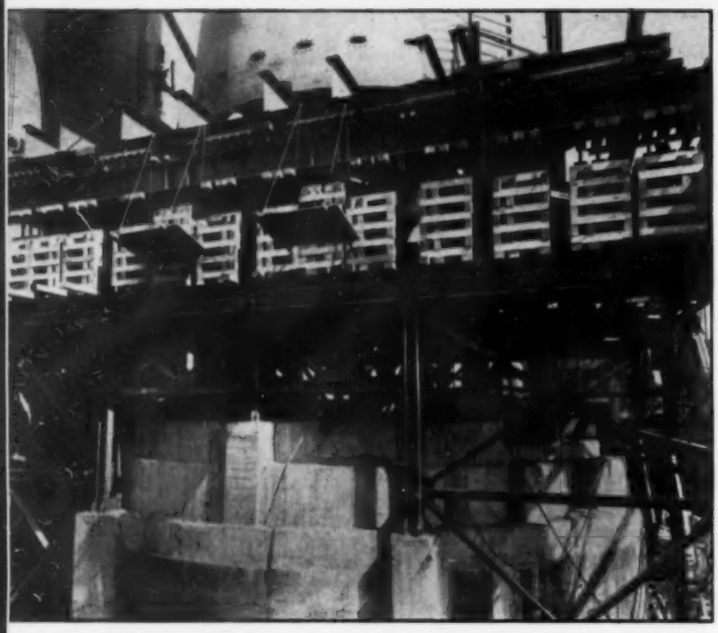
Initial step was the construction, in March, of a trestle to serve as an off-site support and movement track for the furnace shell. The blast furnace builder then erected the steel shell of the furnace on this temporary trestle. After the old furnace was taken off blast and dismantled, there was preparatory work on the site as the old foundation was removed to four feet below the yard level. A new foundation and columns were built to support the replacement furnace, which has a 26-foot hearth and is Youngstown Sheet and Tube's largest iron-producing unit. The replacement included the installation of all new gas cleaning equipment, a new cast house, central coke bins in the stock house, as well as the new furnace and auxiliaries.

The furnace shell and traveling platform, as moved, weighed 650 tons. The weight moved, however, does not indicate the scope of the achievement. Eichleay has already moved a 12,000-ton four-story garage, office buildings, apartment houses, hospitals, department stores, railroad stations, churches, airplane hangars and various industrial equipment, and also once moved a 12,000-ton telephone building while 600 inside employees continued full duty without interruption. But the movement of a blast furnace presented a special challenge because of space limitations and the need for delicate precision.

The shell of a blast furnace has a high center of grav-

The steel shell of the Youngstown Sheet and Tube Company's new No. 1 blast furnace is shown as erected on its "off-site" trestle and moving platform. The photograph was taken the day before the furnace was moved 131 ft to its permanent site. Steel rollers are on the side ribs all set for the movement and the pulley block resting on the metal frame will pull the furnace towards the foreground.





After the lateral movement was completed the furnace rested on a network of cribbing and a battery of 120 jacks at a point 4½ ft above its permanent column supports.

ity, a fact that required careful consideration. The height of the furnace as moved, together with its top structure, was 187 feet and its base diameter was but 40 feet. The trestle and moving frame was 47 feet in height above the supporting foundation. The center of gravity of the furnace shell was 62 feet 6 inches above the mantle ring, which made the combined center of gravity of the furnace and traveler as moved 109 feet 8 inches above the yard level. The structure was nevertheless designed to sustain the maximum likely wind load with an ample factor of safety.

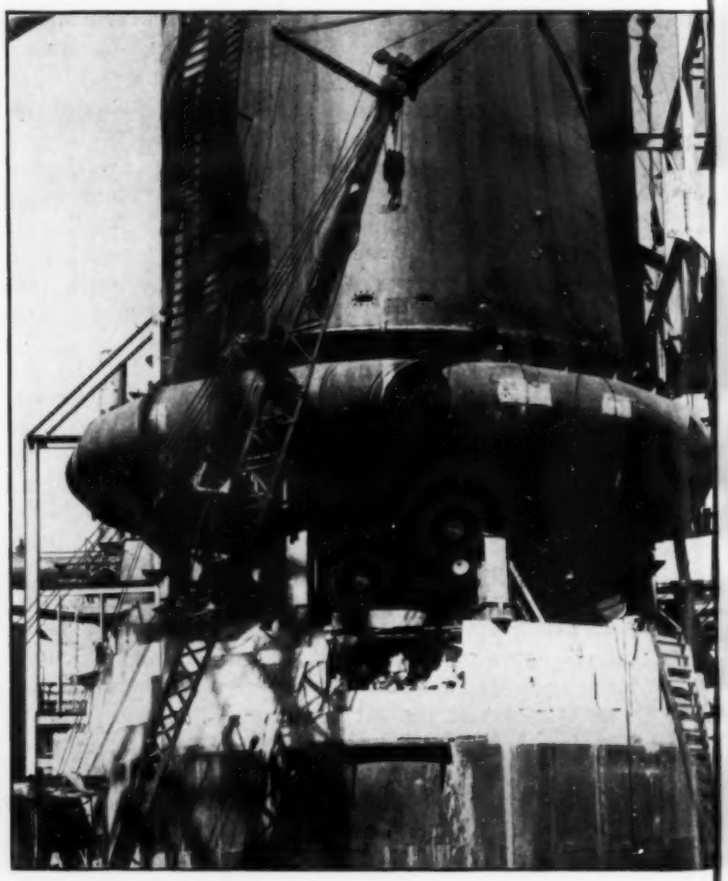
The lateral movement was begun at 8 a. m. on August 5th and completed in 2 hours 40 minutes, with the furnace then in position on cribbing, intermediate steel supports and jacks at a point four and a half feet above its permanent column supports. The furnace and its traveling platform were pulled horizontally over an array of 126 solid steel 3-inch round rollers; the rollers were under pads to permit their removal and transfer. The pulling force was applied by a winch truck through a ⅝-in. wire rope cable laced through four-sheave pulley blocks. The movement was at the rate of two feet per minute with intermittent stops to adjust the steel rollers.

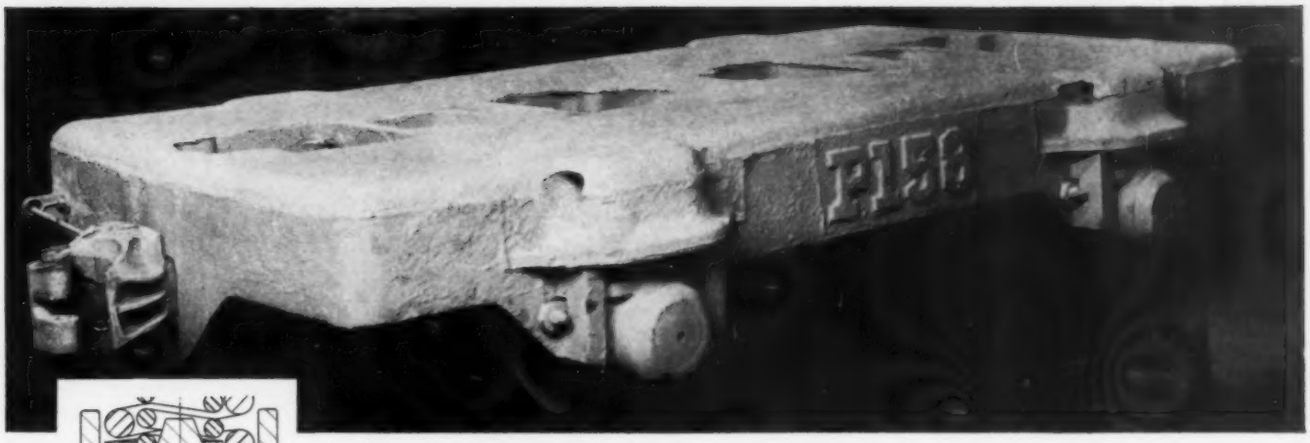
Despite the delicacy of the lateral movement, the most difficult and precise phase of the operation was jacking down the furnace onto its permanent column supports. This was done, as military men would say, "by the numbers." After the furnace was in place over the network of cribbing and a battery of 120 jacks to take up the load, the intermediate steel supports were removed by cutting torch. Then the jacking down was performed by a team of 38 men operating in unison on a bell signal. On each signal of the bell, each man in the team gave a quarter turn to the jacks under his charge. Each quarter-turn of the jacks reduced the height of the furnace by ¼-in. but control supervisors also checked the level with pre-set gages. Periodically, of course, the cribbing had to be removed and the jacks re-set. The lowering operation or fleeting the jacks consumed 22 hours, spread over three days, which included many resettings of the jacks.

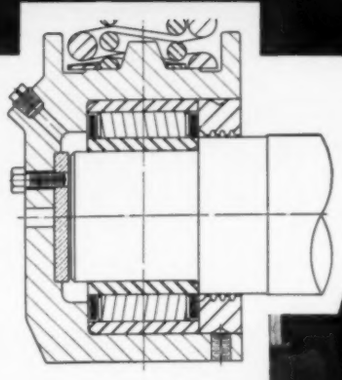
Dismantling of the steel trestle began before the furnace was above its column supports and was completed within 48 hours after the furnace was resting on its nine supporting columns. Where the trestle had been, there proceeded the erection of the cast house for the new blast furnace, and operations soon began on the lining of the furnace shell and the building of the many auxiliaries that make the modern blast furnace such an efficient machine for the production of pig iron.

Until the days of World War II, an operation of this kind had always been considered impossible. Then in 1942, under the pressure of war needs for more and more steel production, the same producer, the Youngstown Sheet and Tube Company, and the same moving and construction firm took a chance on bridging the impossible. The first "traveling blast furnace" in the history of steel-making was built at the producer's Campbell plant in the Youngstown area and went into badly-needed war production in October 1942, some two to three months ahead of conventional construction schedule. The new No. 1 blast furnace at Indiana Harbor proved that it could be done again and there is now an established and perfected technique of building replacement blast furnaces in record time through the use of the off-site erection and moving principle.

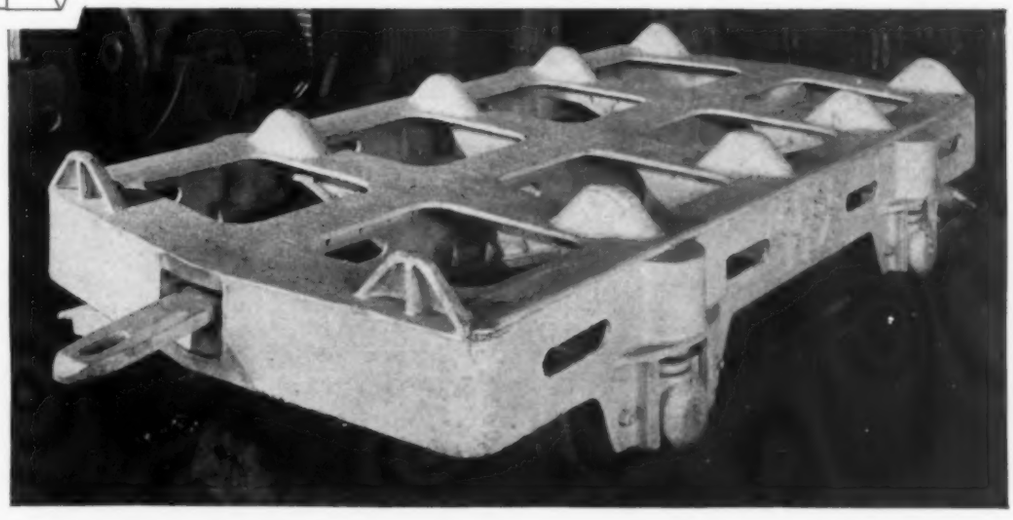
The furnace shell is shown here anchored to its supporting columns and the finishing and lining operations have begun.







A word for the buyer of Ingot and Charging Cars



Most leading builders of open hearth cars regularly supply Hyatt equipment. Photos of Ingot and Charging Box Cars shown, courtesy of Pittsburgh Steel Foundry Corporation.

THAT WORD is HYATT because when cars are equipped with Hyatt Roller Bearings maintenance is simplified—wear is reduced—axle breakage virtually eliminated—longer trains handled more rapidly with less draw-bar pull.

All of which accounts for the reason why more than 90% of the ingot mold and charging box cars used in open hearth plants are operating on Hyatts—the preferred steel mill bearing for cranes, motors and other mill equipment, too, for over thirty years. Hyatt Bearings Division, General Motors Corporation, Harrison, N. J., Detroit, Pittsburgh, Chicago and Oakland, Calif.

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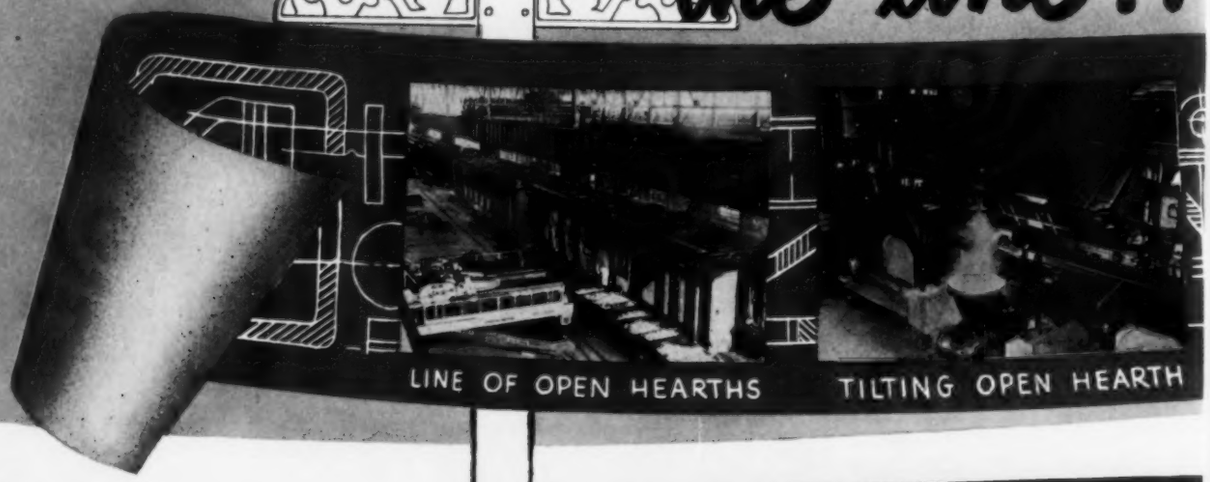

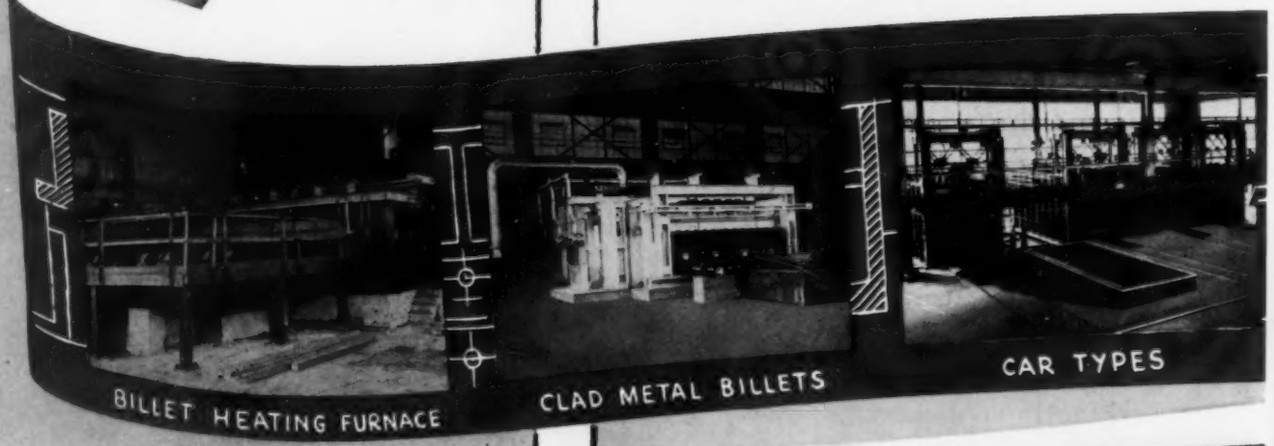

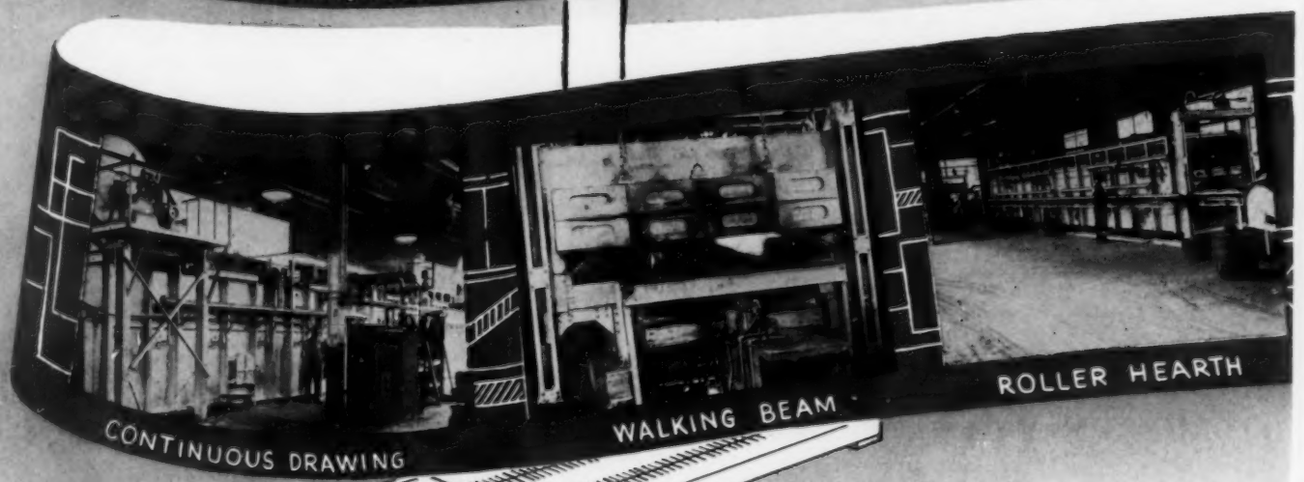

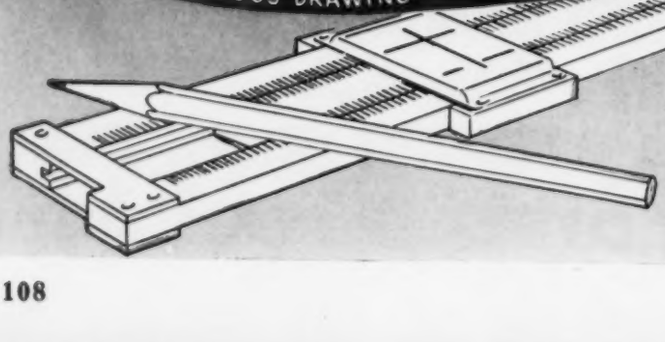

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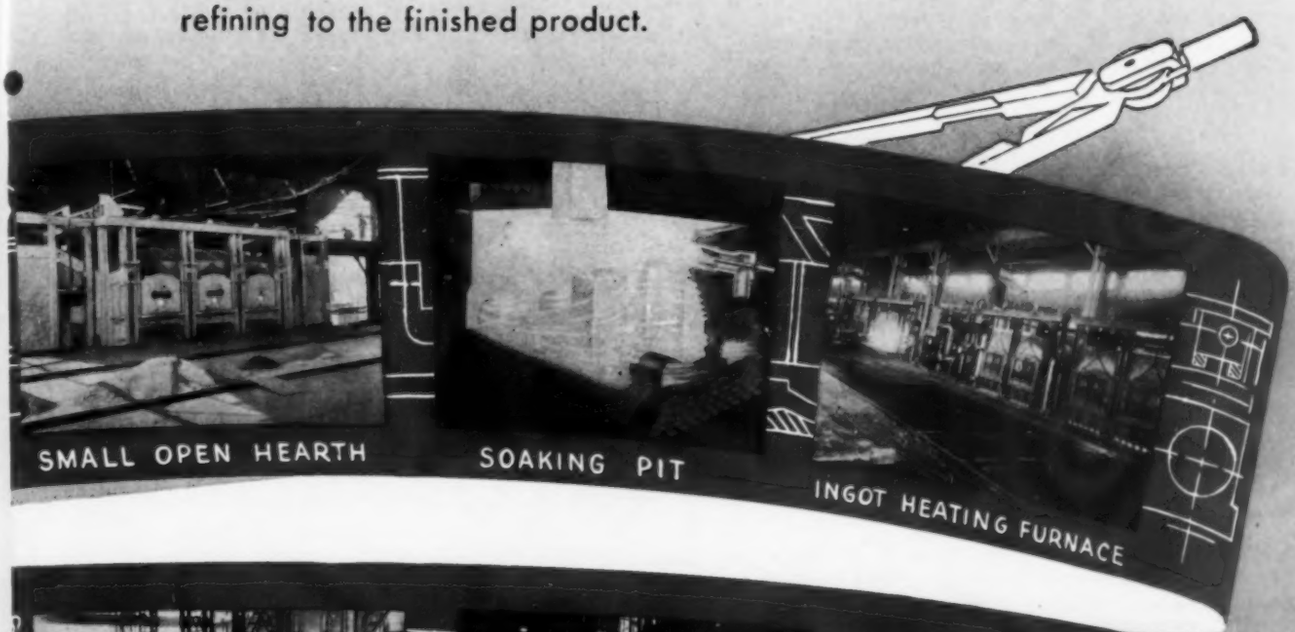

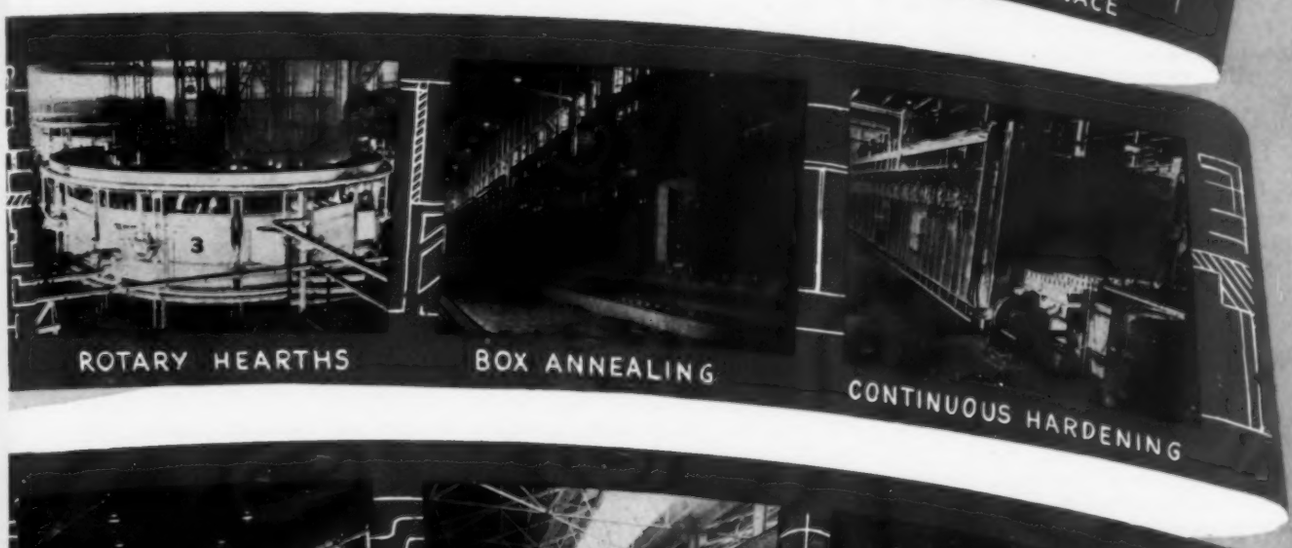

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DATE LINE DIARY...

October 1

▲ Exports of iron and steel products in the first half of 1948 dropped to 2,457,400 tons or 26.5 per cent below the total for the same period one year ago, according to the Department of Commerce.

October 2

▲ The American Iron and Steel Institute reported that in the first six months of 1948 the oil and gas industry received two-thirds as much steel as it had in the entire year of 1947. Shipments to the oil and gas industry in the first six months equalled 2,000,000 tons of steel or 6.2 per cent of shipments. The automotive industry continued to hold first place receiving 4,925,000 tons or 15.3 per cent of total shipments for the first six months.

October 3

▲ The Kaiser Company is planning to build a new blast furnace at their Fontana Plant.

October 4

▲ The operating rate of steel companies having 94 per cent of the steel capacity of the industry will be 97.5 per cent of capacity for the week beginning October 4, 1948 or 1,757,400 tons compared to 1,737,600 tons one week ago.

October 5

▲ Domestic freight car deliveries during September totalled 9753 according to the American Railway Car Institute. The total backlog as of October 1 was 108,907 cars compared with 117,815 cars a month earlier and 115,996 one year ago.

October 6

▲ The third in a series of technical meetings held by the American Iron and Steel Institute took place today and was attended by 300 members of the Institute.

October 7

▲ The United States Steel Corporation, Youngstown Sheet and Tube Company and Interlakes Steel Company raised pig iron prices an average of $3 per ton effective October 4.

October 8

▲ The Colorado Fuel and Iron Corporation announced that the arrangement under which the Republic Steel Corporation had operated the Y Blast Furnace of the Wickwire-Spencer Division of Colorado Fuel and Iron Corporation has been terminated and effective October 1, Wickwire-Spencer has assumed operation of both X and Y furnaces.

▲ The pay roll for the iron and steel industry reached a new peak in August with an estimated figure of $193,800,000. Average hourly earnings of wage earners was $1.689 for August. Employment also set a post-war record of 644,500.

October 10

▲ Standby orders for a large number of machine tools have been placed with builders with actual production, however, starting only in case of emergency or actual war.

▲ The nation's railroads have petitioned the Interstate Commerce Commission to increase freight rates 13 per cent effecting all commodities. They previously petitioned an 8 per cent increase October 1 and are raising this figure and also requesting that the 8 per cent increase be granted in the immediate interim. The new rates would increase coal from 30 cents per net ton to 40 cents per net ton, and iron ore from 24 to 35 cents per ton.

October 11

▲ The operating rate of the steel companies having 94 per cent of the steel capacity of the industry will be 98.5 per cent of capacity for the week beginning October 11th, which is equivalent to 1,775,400 tons of steel ingots and castings compared to 1,757,400 one week ago.

October 12

▲ During the first nine months of 1948 more steel was produced than ever before in peace time, and the total figure of 64,987,478 tons is only two per cent less than in the full year 1946. Steelmaking furnaces operated at an average capacity of 96.1 per cent in September which is a higher average than any other previous month in 1948.

October 13

▲ In an agreement made between Great Britain and the United States, Great Britain will receive 300,000 tons of scrap, United States 300,000 and other countries will receive 100,000 tons.

October 15

▲ Because of increases in purchased alloy elements, the Carnegie-Illinois Steel Corporation announced an increase in its grade extras on alloy steel products which average $5.50 per ton or about 4.6 per cent. Size extras on flat bar alloy products was increased on an average of $5 per ton.

▲ The Vanadium Corporation is opening an all alloy plant at Eddystone, Pennsylvania. This plant is expected to be in operation at the end of October.

October 16

▲ The Carnegie-Illinois Steel Corporation announced today completion of a modernization program at its Vandergrift plant for the increased production of silicon steels. Two new continuous coil annealing lines have started initial operation. The new continuous annealing line uses electric heat radiation.

▲ United States Atomic Energy Commission announced today negotiations with the Vanadium Corporation for the purchase of uranium from two treatment plants, which the Vanadium Corporation will bring into operation in 1949.

October 18

▲ The operating rate of steel companies having 94 per cent of the steel capacity for the week beginning October 18, 1948 is equivalent to 1,786,300 tons of steel ingots and castings compared to 1,775,400 tons one week ago. This is the second highest in the history of the iron and steel industry and larger than ever before in peace time. The all time weekly record of 1,791,300 tons was achieved the week of April 24, 1944.

October 19

▲ Johnstown Works of the Bethlehem Steel Company commenced operation of the first oxygen plant which will produce low purity oxygen for blast furnaces. Initial production will be used in experimentation.

October 20

▲ The Allegheny Ludlum Steel Corporation announced that effective October 11, hot-rolled motor and dynamo grade silicon sheet prices were raised $50 per ton. Some transformer grades were boosted $75 per ton.

October 21

▲ Canada agreed to limit its imports from the United States to 200,000 tons in the fourth quarter of 1948.

October 22

▲ Gwilym A. Price, president of the Westinghouse Electric Corporation reported that new orders during August hit a post-war high of $125,924,357. Government orders made up a substantial portion of this total. Unfilled orders at the end of August also reached a new peace time high of $732,705,333.

October 23

▲ Estimated total bookings of fabricated structural steel for the month of September were 174,671 tons, an increase of 5 per cent over the previous month and 30 per cent greater than 1947.

October 24

▲ J. Lester Perry, president of Columbia Steel Company, announced that Columbia Steel Company took possession from WAA of the site of its future cold reduction sheet mill in the Los Angeles district. This site is located near the existing steel plant at Torrance and consists of 200 acres of land and buildings and was used to house an aluminum plant. The new cold reduction mill will have an annual capacity of 300,000 tons of cold reduced sheet.

October 24

▲ Zinc prices went up one-half cent a lb this week.

▲ The Association of American Railroads expect freight traffic for 1948 to be about 3½ per cent below 1947.

October 25

▲ The National Labor Relations Board for the first time under the Taft-Hartley Act found the union guilty of violating the law by blocking an entrance to a struck plant by means of a picket line. "This interposition of passive force to prevent employees from going to work" is in violation of the new labor law. The board, however, ruled that the strikers could call non-strikers names as this does not constitute intimidation.

▲ The General Motors Corporation, Fisher Body Division, stated that they were negotiating with the Navy for the lease of a former war plant at Ambridge, Pennsylvania. This plant apparently is the ship yard which was operated by the American Bridge Company during the war. This plant shift was probably initiated because of the ruling of the FTC on F.O.B. prices. In addition the Fisher Body Division will start erection of a 600,000 sq ft stamping plant on a 65 acre site next to the Irvin Works.

▲ The operating rate of steel companies having 94 per cent of the steel capacity of the industry will be 98.9 per cent of capacity for the week beginning October 25. This is equivalent to 1,782,600 tons of steel ingots and castings compared to 1,786,300 tons one week ago.

October 26

▲ Secretary of Commerce Sawyer predicts that 1949 will see a copper shortage of 100,000 tons, a lead shortage of 124,165 tons and a zinc shortage of 47,700 tons. These figures may also be increased because of stock piling.

▲ Henry Kaiser offered to lease the Gadsen, Alabama, government owned blast furnace under the same conditions which he leased the Cleveland furnace, in the event that Republic chooses to quit operating this plant, or in the event that the foundry industry does not establish a cooperative company to lease it. Mr. Kaiser stated that in the event that he leased the premise, it would be his policy during the foundry iron shortage to sell to consumers of foundry pig iron.

▲ Jones and Laughlin Steel Corporation increased their quarterly stock dividend to 65 cents a share for the third quarter of 1948. This dividend has been maintained at a rate of 50 cents per share quarterly since October 1942. Dividend is payable January 5, 1949.

▲ The Jones and Laughlin Steel Corporation announced a large post-war steel expansion program. In this expansion, six large new open hearths will be built in Pittsburgh, rated at 780,000 tons annually, which will give the company an increase of 400,000 tons of capacity after obsolete units are retired.

October 27

▲ Production in the Bizonia section of Germany during October was about 572,000 metric tons of steel. This is an increase of 5 per cent over June, when the currency reform took effect, and this increase has been attributed to the currency reform.

▲ United States Rubber Company announced today increases of 5 to 10 per cent in prices of electrical wire and cable effective November 3, 1948.

▲ The Carnegie-Illinois Steel Corporation and National Tube Company announced today because of the increase in the price of zinc of one-half cent a lb made October 23rd, they are revising extras for galvanized sheet products an average of about $1.25 a ton and galvanized pipe about $1 a ton. The average per cent increase is about 1 per cent.

October 28

▲ A new continuous mining machine which digs and loads soft coal at a rate of three tons or more a minute was demonstrated at the mine of the Sunnyhill Coal Company near New Lexington, Ohio. The Colmol combines two operations, breaking and loading, and it is estimated that it can turn out 1000 tons a shift. This machine as yet is not in production.

▲ The Sharon Steel Corporation sold the physical assets and inventory of the tube division of the Detroit Tube and Steel Company to Glenn H. McCarthy and International Rolling Mill Products Corporation.

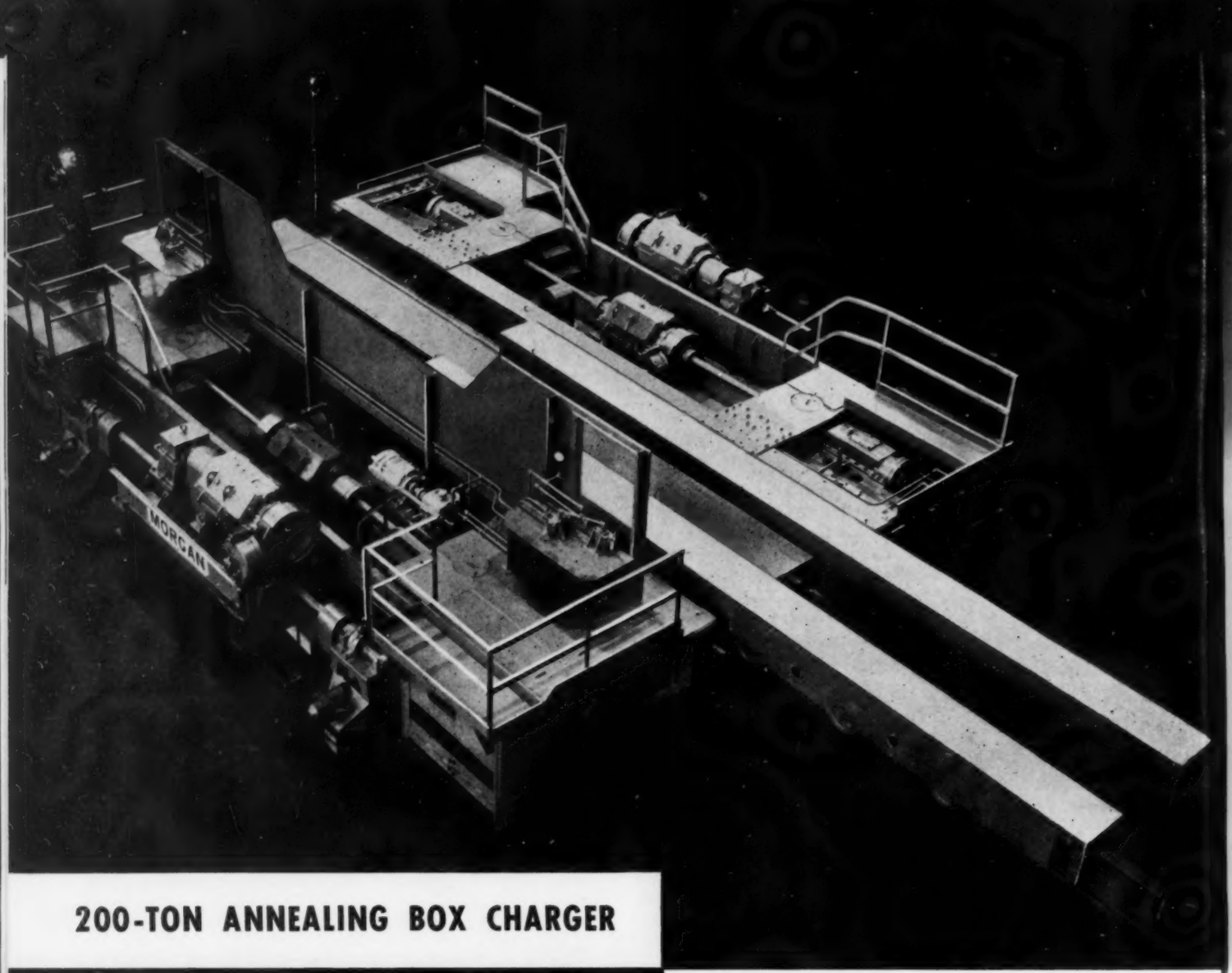
October 29

▲ Third quarter corporation reports show that earnings are climbing to new records and 1948 looks like a record year for profits. Sales are apparently still passing rising costs. In these returns the steel industry is showing strength. Profits of twenty-four of the nation's largest steel producers jumped 4 per cent in the first nine months, and net profits for the first three quarters rose $332,918,766 compared to $291,929,690 for the corresponding period in 1947.

October 31

▲ American Steel and Wire Company closed its Donora Zinc Works pending outcome of an investigation by health authorities into the smog which hung over the valley during the week end. Twenty residents of the area died, all of whom were apparently elderly and had asthma or heart trouble. A thick haze and smog which hung over the area for several days apparently contained something which caused a partial paralysis of the diaphragm in the victims, and only oxygen seemed to bring relief. The Donora Zinc Works were reopened on November 4th, after an investigation by the Pennsylvania Department of Health and United States Public Health Service which reported, "There is at present no evidence of any kind which would incriminate any one mill as the source of atmospheric contamination which was harmful."

▲ As Parliament was opened England's King George proposed in his speech legislation to "... bring under public ownership those companies extensively engaged in the production of iron ore, or of pig iron or steel or in the shaping of steel by a rolling process." Several days later the labor government's bill was made public and it calls for the nationalization of 107 companies which represents over 90 per cent of the whole industry and 300,000 workers. Private owners would be compensated at the market values of their holdings.



200-TON ANNEALING BOX CHARGER

BUILT BY MORGAN Engineering

Illustrated is a Morgan 200-Ton, 5-motor, 19′-3½″ Span Annealing Box Charger. It consists of a traveling bridge upon which are mounted two rack driven charging trucks operating in unison for raising the annealing boxes and moving them into or out of the furnace or onto the cooling beds. The charging trucks are operated by two motors through four worm units with provision for operating either of the two motors alone.

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NEWS SUPPLEMENT NOVEMBER, 1948

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Iron AND Steel ENGINEER

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AMERICAN BRAKE SHOE COMPANY OPENS NEW NON-FERROUS FOUNDRY IN PENNSYLVANIA

▲ National Bearing Division of the American Brake Shoe Company recently announced the opening of its new non-ferrous foundry, the newest of Brake Shoe's six post-war plants, at Meadville, Pennsylvania. Having closed four old plants in the National Bearing Division, the company is concentrating production for the eastern area in the new Meadville foundry. Located as it is in the heart of the country's steel producing area, Meadville was a logical choice for the new plant since it placed National Bearing nearer to users of blast furnace castings, steel mill bearings and industrial non-ferrous parts.

Operations have been discontinued at former plants in Jersey City, New Jersey, the old plant in Meadville, and two other plants in Pittsburgh, Pennsylvania. When in full production, the new foundry will greatly exceed the combined productive capacities of the four old plants. It will provide complete machining facilities which were not available in any of the old plants.

Plant description — Ground was first broken for the new Meadville plant in August 1946. Construction was completed in December 1947. The new plant has a total of 185,245 square feet of floor space or the equivalent of nearly 4½ acres under one roof. This includes a two-story office and employee service building; the main foundry building and machine shop, which measures 735 x 250 feet, and a heating plant housed in a separate unit. All construction is of brick, concrete and structural steel.

The new Meadville plant was planned and constructed so as to provide conditions under which workers can devote their full production skill to the job. Clean, light and airy, it is equipped with the best means of material handling to eliminate back-breaking labor. It is the type of plant where intelligent, experienced men want to work. To industrial buyers this combination of better working conditions and better equipment means top quality products.

Ventilation and heating—The most efficient possible ventilation has been provided in the Meadville plant—one of the many ways in which Brake Shoe has made this plant a better place to work. The ventilating system is so designed that some areas of the plant have as many as 8 changes of air a minute—others a change of air every 10 or 15 minutes, depending on the need.

Patterns — Highly skilled in their trade, the plant's 10 patternmakers make patterns of any size, shape and complexity. The larger sizes are limited only by the facilities which are available for making the actual casting.

Sand-handling — Sand-handling, a laborious and dirty job in old time foundries, is entirely mechanical at Meadville. Three different systems are installed—one to handle dry sand, one to handle green sand, and an entirely separate system which is used for core sand.

Core room—Equipment in the core room includes: 1 jolt rollover draw machine; 2 jolt-squeeze machines; 3 core-blowers and bench; 1 core-making machine, and a sand-conditioning unit separate from that for the holding department. This unit includes a weighing scale and 2 muller-type mixers. Four rack-type ovens and one car type oven, all electronically controlled, handle core baking. Large cores are handled directly from core department to the mold set-up

The National Bearing Division of the American Brake Shoe Company plant at Meadville, Pennsylvania has over 400 sq ft per employee (higher than the industry average). The visitor is particularly impressed with its labor saving equipment.

Diesel engine bearings are stacked at one end of the machine shop.

floors. All core sands are delivered by overhead cranes to core-making stations.

Molding department — The floor molding section at the Meadville plant is serviced by a sand-slinger which is used for medium and large molds of both green and dry sand. The section has a 10 ton and a 5 ton overhead crane, also 2 shakeouts, one for green and one for dry sand. A large mold drying oven is nearby in which molds up to 14 x 16 feet and 12 feet high can be dried. A molding pit measuring 10 x 15 x 20 feet is provided for handling large molds.

The machine molding floor has a capacity of approximately 1200 molds a day. Equipment here includes one jolt-rockover mold machine, 2 jolt-squeeze rollover draw molding machines, 3 jolt-squeeze strip and 3 jolt-squeeze molding machines. A conveyor carries molds from the machines to the pouring area. Molds are returned by gravity to two shakeouts where they are mechanically shaken out. In this section air is changed once every minute.

Furnaces — The new Meadville plant has a total melting capacity of approximately 200,000 pounds a day. Heats are made up in units of 800 pounds and an average of 12 different alloys are poured in a day (sometimes as many as 16). The department is flexible for individual furnaces range in size from small crucible type floor furnaces which handle heats as low as 100 pounds to the big reverberatory furnace which handles heats of 20,000 pounds. There is a minimum of delay in the production of either small or large special analysis castings.

All raw materials when brought into the plant, are weighed, classified, and stored in boxes for easy handling to the mezzanine charging platform. All metals are taken to the charging platform with a high-lift truck. Heats for each furnace are made up in special charging buckets on a traveling scale, then placed on a conveyor behind and above the furnace. Furnaces are charged through gravity loading chutes with a minimum of handling. No time is lost between charges. As molten metal leaves the furnace, recharging is possible at once.

The furnace department includes:

1. Two cupolas.
2. Six direct-fire rotary type furnaces.
3. Seven pit type crucible melting furnaces.
4. Two tilting type crucible melting furnaces.
5. One small tilting reverberatory type furnace (capacity of 3000 lbs.)
6. One large reverberatory furnace (capacity of 20,000 lb.) This furnace is the largest of its kind in all National Bearing Division plants and is used in the production of large castings. An ingot mold conveyor is attached to it which allows the furnace to also be used to refine metals as well as to produce ingot for the smaller furnaces.

Reclamation room—All skimmings from ladles and slags from furnaces are processed through the plant's reclamation unit. These materials are crushed by means of a mechanical crusher, classified according to size, and then processed by flotation so that all metal is separated from slag. Reclaimed metal is then melted down and ingot analyzed for reuse in the plant.

Machine shop—The Meadville machine shop has a total area of 36,400 square feet of floor space. Equipped with 97 of the most modern tools for machining to close tolerances, it has a production line setup for diesel engine and other precision type bearings as well as motor traction bearings of all types.

Finishing and inspection—The finishing department has been carefully laid out in such a way that castings move on practically a production line schedule from the rough inspection, chipping and cleaning, through to grinding and tumbling, welding and heat treating (where necessary), and finally on to physical testing and final inspection. Chipping is done in individually exhausted booths.

Products — Copper castings for blast furnaces, electrode holders, bronze structural castings, diesel engine bearings, locomotive wearing parts and car bearings, bronze steel mill bearings and castings, babbitt metal, acid-resistant bronze castings, pump impellers and housings, bronze and copper structural parts, gear blanks and industrial manganese and aluminum bronze structural castings (up to 30,000 lb.)

Founded in 1902, American Brake Shoe Company, with its ten divisions and four foreign subsidiaries, manufactures products for the railroad, automotive and most general industries. The company operates a total of 60 plants, over 40 of which are foundries.

Since the war American Brake Shoe has completed a plant replacement and expansion program which has involved expenditures of approximately $15,000,000. The primary purpose of the program has been to eliminate old, high production cost plants and to improve quality of company products through improved techniques and the application of the findings of company research and engineering.

Two oil-fired furnaces are shown in operation in the furnace bay.

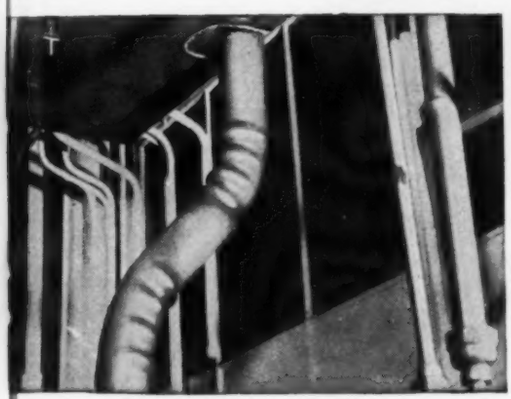
J & L ANNOUNCES EXPANSION PROGRAM

▲ Admiral Ben Moreell, president of the Jones and Laughlin Steel Corporation, announced an important expansion program on October 26, 1948. Excerpts of his announcement follow:

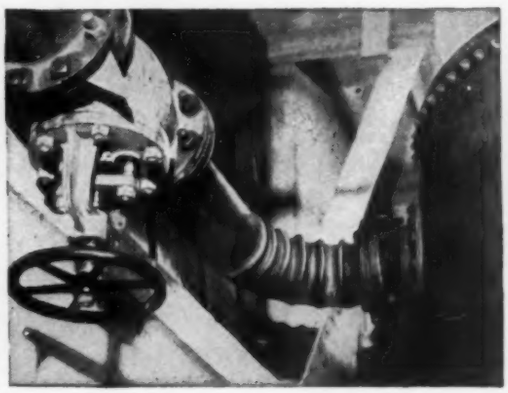
"In our 1947 Annual Report I referred to the large expenditures, aggregating $103,000,000, for improvements to our property, plant and equipment which had been authorized during the two-year period

(*Please turn to page 118*)

"Tailor-Made" Bends

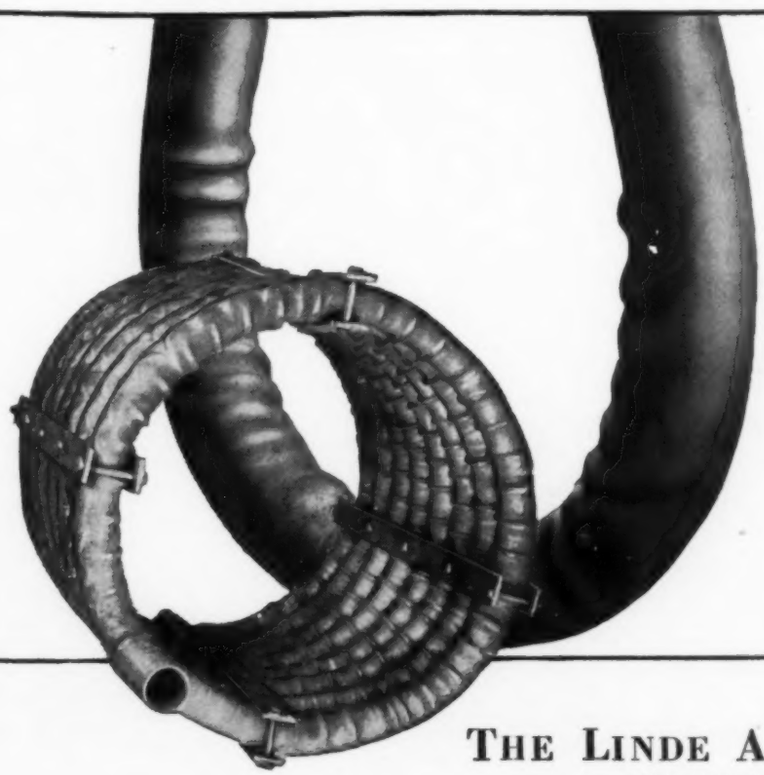


Where compound bends are required in a continuous section of pipe, wrinkle-bends offer an ideal solution. Wrinkle-bends are leakproof, as strong as the pipe itself, require no maintenance, and are easy to insulate.



This short-radius wrinkle-bend joins a compressed air line to a reservoir. Wrinkle-bends can be made in brass, copper, aluminum, and steel pipe from 2 inches to 26 inches in diameter.

Pipe bends can be made right on the spot with the aid of an oxy-acetylene welding or heating blowpipe, a simple bending rig, and a few common tools. Wrinkle-bending does not reduce the thickness of pipe walls.



This condenser coil made from 2-inch stainless steel pipe has 350 wrinkle-bends.

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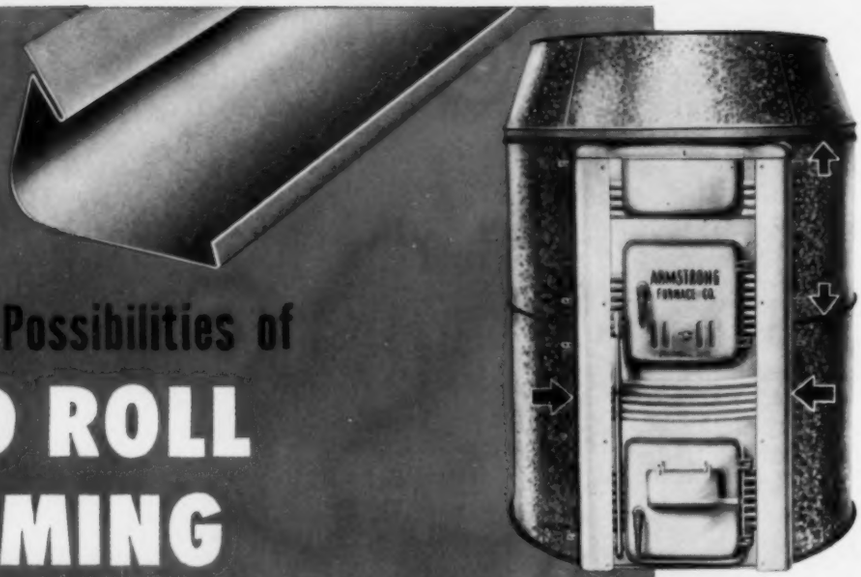


Explore the Possibilities of COLD ROLL FORMING in your product design

For lower unit cost, greater uniformity and accuracy, finer surface finish, lighter weight, greater strength—cold roll forming from coiled strip or sheet metal holds unsuspected possibilities in the mass production of many things.

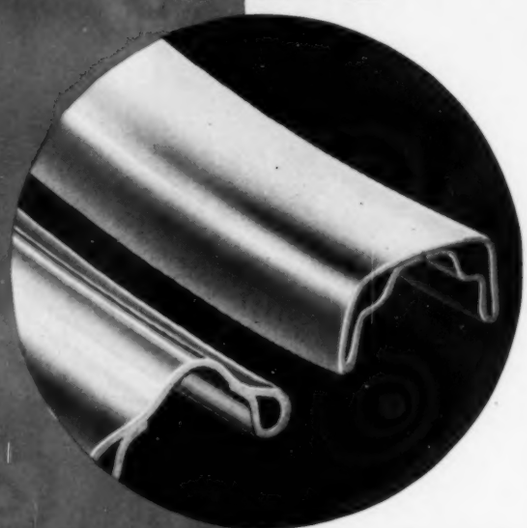
Take, for example, the cold roll-formed furnace front pilaster section by the Armstrong Furnace Company, Columbus, Ohio—a new streamlined design successfully replacing the heavy, conventional furnace fronts.

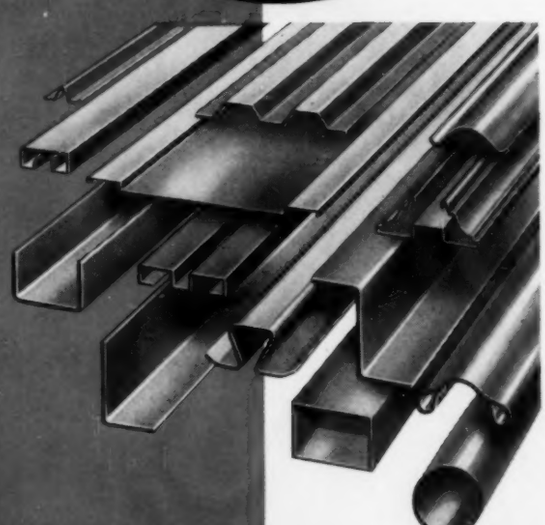
Or take the case of the two twin tubular bicycle rim sections, shown in circle, which are continuously cold formed, seam welded, coiled and cut off so accurately that the individual rings resulting come within $\frac{1}{16}$" of absolute circumferential accuracy. All these operations are performed in one single Yoder-engineered production line, by only one operator.

Cold roll forming, in these and in many other instances, may be so designed as to eliminate one or several operations heretofore necessary, simplifying fabrication and assembly, at a drastic reduction in unit cost. Other operations may also be included in the cold roll-forming production line, such as slitting, edge trimming, welding, embossing, curving, coiling, perforating, etc.—at little or no extra labor cost.

Literature • Consultations • Estimates

THE YODER COMPANY
5497 Walworth Avenue • Cleveland 5, Ohio





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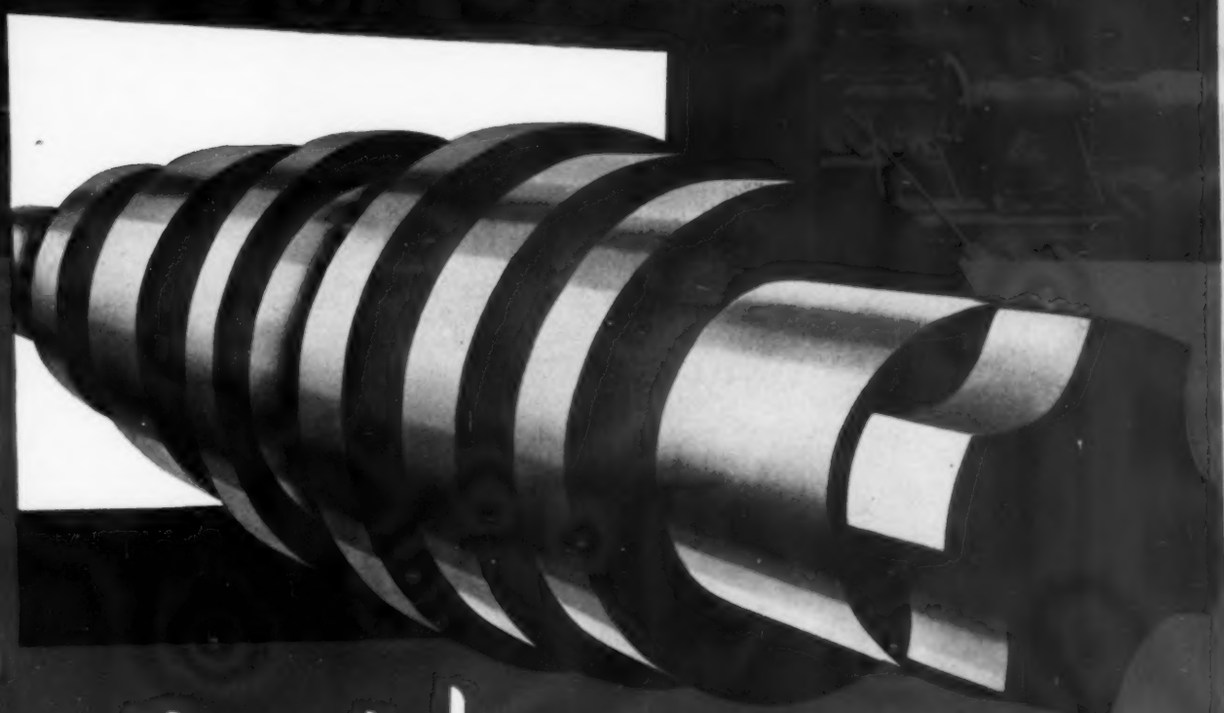

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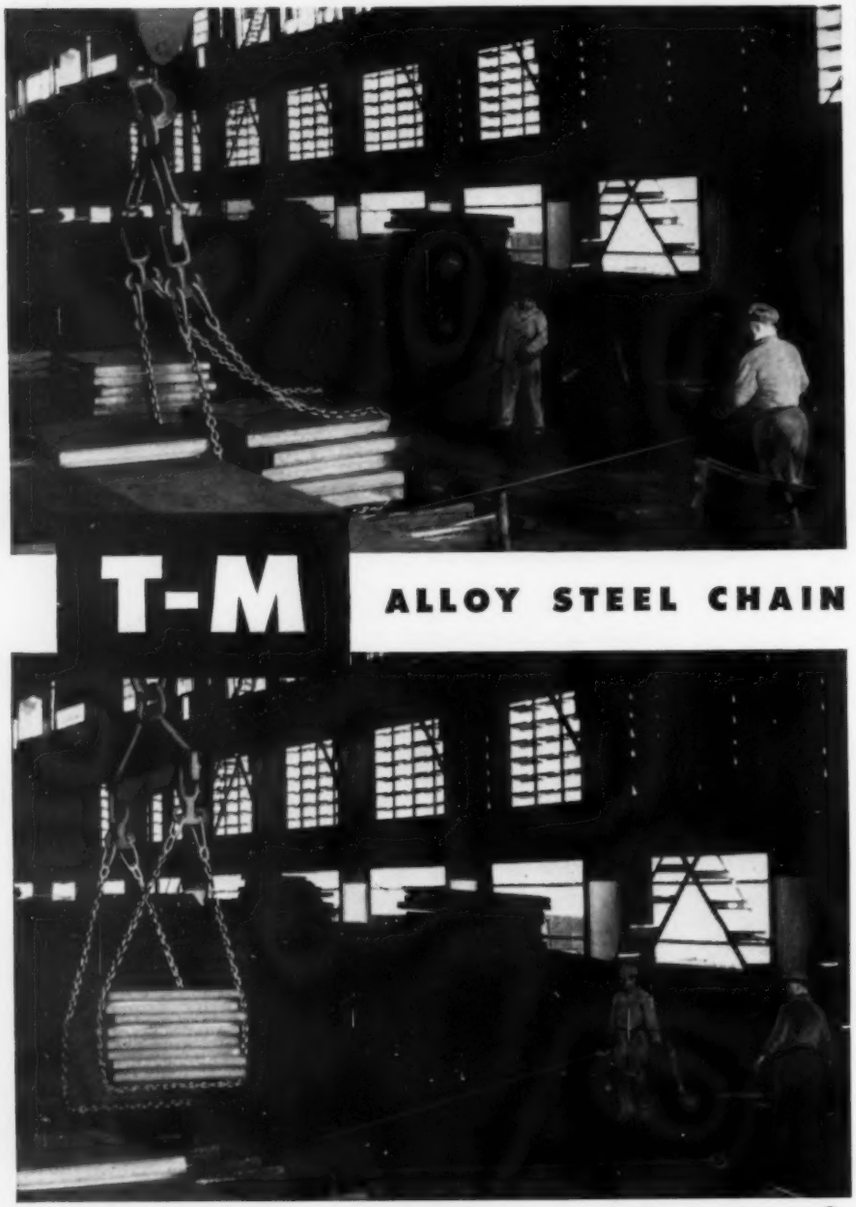

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MANUFACTURERS OF BBB, PROOF COIL, HI-TEST, STEEL LOADING CHAIN AND CHAIN SPECIALTIES

TAYLOR MADE Chain

75th ANNIVERSARY ★

(*Continued from page 114*)

ended December 31, 1947. We have authorized through September of this year further improvements which together with expected additional overruns amount to approximately $26,000,000.

During recent years we have made large expenditures for coal and ore mining additions and improvements, for coke oven additions, blast furnace improvements, and for finishing mill additions and improvements. These undertakings are important parts of our plant development program, which is designed to effect progressive improvement of the Corporation's earnings, with particular regard to our competitive position during periods when there will be a lessened demand for steel. We are now beginning to realize substantial benefits from the large expenditures made during the past two years.

The improvement of our steelmaking equipment at Pittsburgh works has been under consideration for several years. In 1947 at this works we made approximately 145,000 tons of ingots in small 60-ton open hearth furnaces built in 1896, and approximately 235,000 tons in similar furnaces built in 1917. This total of almost 400,000 tons of ingots, out of approximately 2,000,000 tons produced at Pittsburgh works last year, represents high cost marginal production. The demand for steel is so great, however, that to serve our customers adequately we can follow no other course for the present but to continue these obsolete furnaces in operation until we install sufficient modern capacity to permit their abandonment.

For many years we have relied heavily in Pittsburgh works on bessemer and duplex steelmaking practices. These practices now account for about one-half the ingot production at this works. In line with the present trend of our product pattern and of requirements for best operations, we propose to increase amounts and proportion of scrap and hot metal practice open hearth steel, at the same time eliminating the use of the small, obsolete open hearth furnaces. These purposes will be accomplished simultaneously by building additional modern open hearth furnaces.

We plan to build a new open hearth shop of six large furnaces at Pittsburgh works which will provide an increase in the productive capacity

of our steelmaking equipment as the result of their ability to melt additional scrap. More steel will be produced with the same amount of blast furnace iron. No new blast furnaces are planned, although some of our existing blast furnaces have been or will be enlarged during relining periods, and additional blowing capacity as well as improved raw materials will result in more iron production.

The construction of the six new open hearth furnaces, together with the availability of additional iron resulting from blast furnace and raw material improvements, will result in a net increase of total ingot capacity at Pittsburgh works amounting to over 400,000 tons annually after the abandonment of the small obsolete furnaces previously referred to. The additional ingots can be put through the existing blooming mills at Pittsburgh with a relatively small investment for soaking pit capacity. Upon the rebuilding of the slab heating furnaces at our present 96-inch hot strip-sheet mill, which must be done in any event and which is now under way, the product of the additional tonnage can all be rolled on this mill.

The resulting hot rolled coils from the strip-sheet mill will be used to increase production of cold rolled sheets and tin plate. Sufficient cold reducing capacity is presently available for substantial increases in these products. Finishing facilities will be extended in both departments, and, in keeping with the trend of demand, additional capacity will be installed for electrolytic tin plate.

The project I have described indicates a satisfactory return on the investment based both on capacity rates of operation and on lower rates of operation. The value and need of the project to the corporation are considered to be particularly great in periods of lessened demand for steel products. The return at lower rates of operation would be aided by the fact that, as demand declines, production would be concentrated to a greater proportionate extent on the new equipment.

One of the most important elements in steelmaking operations is flexibility, the ability to increase production quickly, as is possible in the bessemer and duplex practices, and yet to have sufficient open hearth furnace capacity to permit operations on a high scrap charge as demand declines and scrap becomes cheaper. We expect to achieve an important increase in flexibility with the completion of the new open hearth shop. In

HYDRAULIC JACK SIMPLIFIES LIFTING

A new hydraulic jack with an independent pump is announced by The Duff-Norton Manufacturing Company. The new "Lo-Hite" jack simplifies many heavy lifting jobs in and around steel mills, such as: replacing brasses in journal boxes of locomotives, positioning plates for welding, aligning springs on locomotives, pushing bushings, pulling gears and gear boxes, replacing bearings, wheels, and general repairs on overhead cranes, general repair work on mill machinery, straightening car sills in close quarters, straightening pipe, repairing bridges, lifting ties and many other uses.

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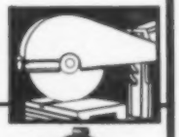

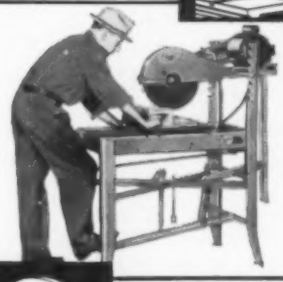

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The New Model HD-48 Clipper cuts dry just exactly the same as regular Clipper Masonry Saws.. and for Dustless masonry cutting just turn on the circulating system and slice thru the hardest materials. Proven by ten years use throughout the world. Guaranteed to provide the fastest cuts with lowest cost.

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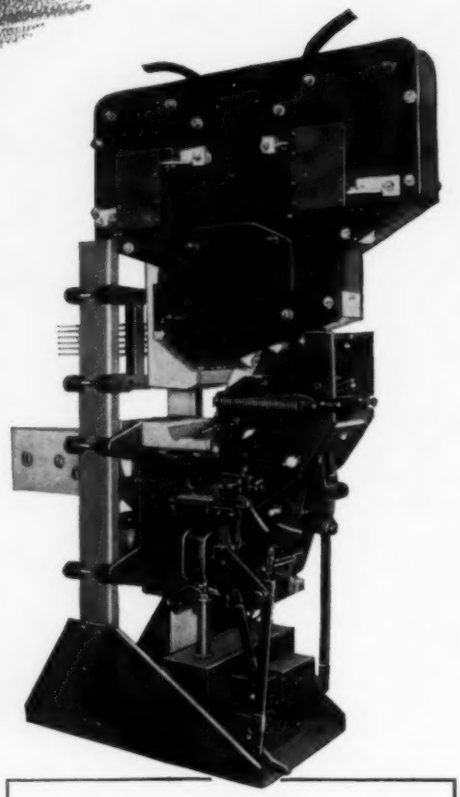


Electrical disturbances can't spread trouble with this *more dependable, better built* breaker on the job!

• Short circuits and extremely heavy overcurrents don't have a chance to ruin your essential generators, motors, rectifiers, and connected production equipment—when your electrical distribution system is protected by proper application of I-T-E Type MT Automatic Reclosing Circuit Breakers.

The MT was specially developed by I-T-E—*Switchgear Specialists*—for interrupting extremely heavy direct currents. It breaks a circuit in .028 seconds (about 1¾ cycles on a 60 cycle basis) at 25% to 100% of interrupting capacity. I-T-E's *Rate-of-Current-Rise* Trip anticipates extremely heavy currents—distinguishes between a useful load of high value and a dangerous fault current—and trips the breaker before the danger peak is reached. Shorts and overcurrents are cleared instantly, dependably, before they have a chance to cost you money.

And with the MT breaker, you get an exclusive I-T-E "extra"—*better design* to give you the benefits of manufacturing savings which, in turn, allow higher-quality refinements *at no extra cost*.

Complete details on the I-T-E Type MT Air Circuit Breaker (including Automatic Reclosing Applications) are contained in illustrated catalog 2202. Send for your copy.

TYPE MT — for pedestal mounting. Single pole, electrically operated. Application: 250 and 750 Volts. Interrupting rating is 150,000 Amp. in continuous ratings 2000 and 4000; 250,000 Amp. in continuous ratings 6000 and above.

ARC EXTINCTION IN THE MT AIR BREAKER

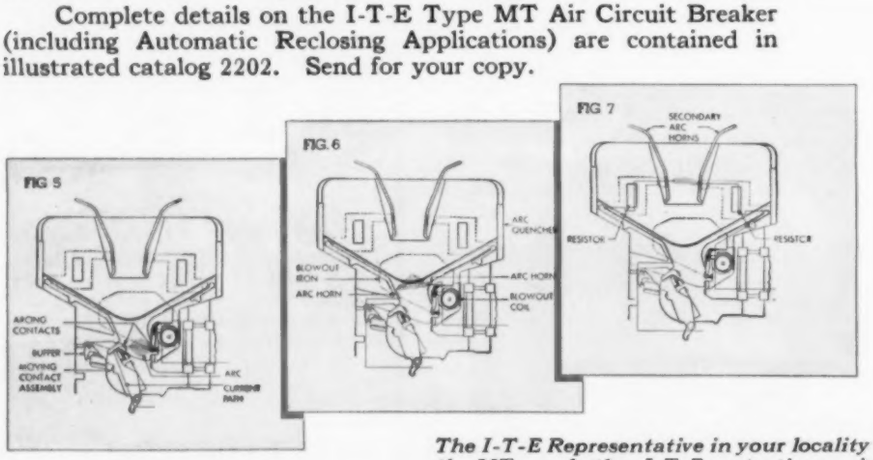


FIG. 5 First stage in circuit interruption: Arc drawn between arcing contacts; blow-out coil in circuit.

FIG. 6 Second stage: Arc transferred to arc horns.

FIG. 7 Final stage: Arc transferred to secondary arc horns; resistors in circuit.

The I-T-E Representative in your locality will be glad to advise you on applying the MT—and other I-T-E protective equipment—to your electrical distribution system. Use his services without obligation.

I-T-E R&IE *

MILL TYPE SWITCHGEAR

The Leader In Technical Excellence

I-T-E CIRCUIT BREAKER CO., 19th & HAMILTON STS., PHILA. 30, PA. — 31 OFFICES IN THE UNITED STATES
In Canada, EASTERN POWER DEVICES, Ltd., TORONTO

SWITCHGEAR • UNIT SUBSTATIONS • ISOLATED PHASE BUS STRUCTURES • AUTOMATIC RECLOSING CIRCUIT BREAKERS • HIGH SPEED CIRCUIT BREAKERS
*FOR POWER SWITCHING EQUIPMENT, REFER TO RAILWAY AND INDUSTRIAL ENGINEERING CO., AN I-T-E SUBSIDIARY

periods of high demand we have been able to reach peak production quickly. On the other hand, with our present steelmaking practice, when demand recedes we have not had enough large open hearth furnaces to take full advantage of cheap purchased scrap.

The estimated cost of the project including the new six furnace open hearth shop and the necessary corallary and finishing facilities located at Pittsburgh and Aliquippa works, is approximately $70,000,000. The entire project, however, is contingent upon satisfactory completion, at reasonable cost, of the acquisition of additional land adjacent to our present Pittsburgh works.

JONES & LAUGHLIN BUYS HUGE MOBILE CRANE

▲ A spectacular advance in mobile equipment for handling heavy materials, which makes possible the lifting and transporting of loads heretofore beyond the capacity of such equipment, is signalized by announcement from Thew Shovel Company of a giant, rubber-tired, two-engined moto-crane, said to be the world's largest.

Purchase of the first of the new units by Jones and Laughlin Steel Corporation for its Aliquippa works puts the world's largest moto-crane into operation in the world's largest steel mill.

By its ability to lift and transport much heavier loads than could previously be handled by rubber-tired crane, the "MC-820 Moto-Crane"

This is said to be the world's largest rubber-tired mobile crane.

For fast, positive and dependable operation...

● Quick-as-Wink valves have demonstrated repeatedly their outstanding superiority and efficiency for controlling the operation of presses, forging machines, shears, brakes, body presses, steel mill equipment, rubber mill equipment and other heavy duty and important machines and machinery of all kinds. The U-shaped packers are expanded by pressure and seal tightly, preventing leakage. There is no creeping or crawling—no lapping, no grinding, no metal-to-metal seating. Every valve is a quality control, precision made and individually tested.

Furnished in hand, foot, pilot, cam solenoid and diaphragm operated designs for controlling all types of air and hydraulic equipment . . . Let us work with you on your requirements.

Quick-As-Wink Solenoid Operated Air Valves

The 1491-CS-3 is a 3-way solenoid operated valve with automatic spring return. These valves are widely used for controlling single action air cylinders, clutches, etc. and can be operated with a variety of power switches, mercoid switches or automatic contact switches activated by moving objects.

2-way, 3-way and 4-way valves are available in single and double solenoid types. 3/8"; 1/2"; 3/4"; 1" and 1 1/2" sizes for air up to 125 lbs. pressure.

Send for a catalog today and get full details about the complete line.

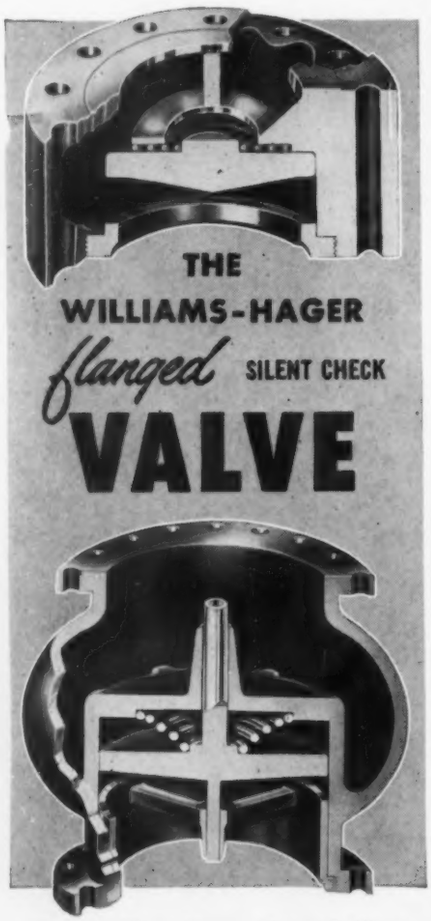
Quick-As-Wink Control Valves

THE HIGHER THE PRESSURE THE TIGHTER THE SEAL

Manufactured by **C. B. HUNT & SON, Inc.,** *Salem, Ohio.*

Engineering and Sales Representatives in the Principal Cities

STOP WATER HAMMER



The Williams-Hager Flanged Silent Check Valve is available for every service . . . bodies of Iron, Semi-Steel, Cast Steel, Government Bronze, Stainless Steel or Monel Metal . . . fitted with seats and discs of either Government Bronze, Stainless Steel or Monel. Standard sizes from 1 inch to 20 inches. *Write for new technical bulletin.*

THE WILLIAMS GAUGE CO.

Pump Valves . . . Water Gauges . . . Gauge Cocks . . . Steam Traps . . . Pump Governors . . . Feed Water Regulators . . . Water Columns

3076 PENNSYLVANIA AVE. · PITTSBURGH (12), PA.

greatly extends the rubber-tired crane's basic advantages in heavy-duty crane service as, for example, in steel mills, steel erection, ship building, bridge building, logging, oil fields, and any other industries where the handling of heavy materials is an essential operation. Many applications are anticipated as industry gains experience with the new unit.

Weighing 65 tons, the new monster moto-crane has the following overall dimensions: length, with boom in travel position over front of carrier, 66 ft, 5 in.; width, outside to outside of tires, 11 ft, 7¾ in.; height with gantry erected 19 ft, 5 in., with gantry lowered 14 ft.

The crane comprises two basic components. These consist of the carrier, or rubber-tired mounting, which transports the unit from place to place; and the turntable, or revolving superstructure, which is attached to the carrier frame.

While the carrier is automotive in general design, it has been engineered specially to serve as a mounting for heavy-duty crane lifting service and therefore, departs from the ordinary motor truck design in many respects.

LIQUID RHEOSTAT SHOWN AT AISE EXPOSITION

▲ Featured in the Allis-Chalmers exhibit at the AISE Iron and Steel Exposition, September 28 through October 1 at Cleveland, Ohio, was a liquid rheostat operating under simulated load conditions to provide stepless, precise speed control, together with control cabinet and motor-generator Regulex set.

Used for wide range speed regulation by secondary control of wound rotor induction motors, Allis-Chalmers improved liquid rheostat is being applied to solve many of today's control problems. It is especially adaptable for speed control of wound rotor motors which have a load with a definite speed versus load characteristic, such as those driving a fan or pump.

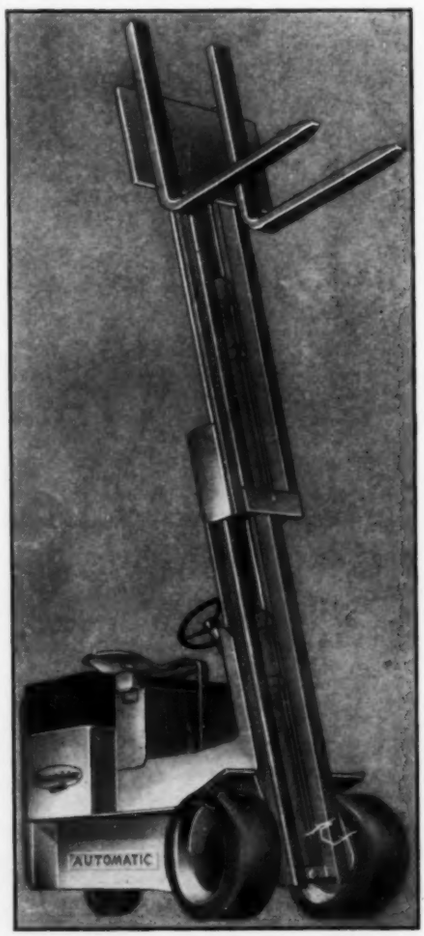
Also on display was a d-c sinusoidal positioner-operated recorder demonstrating the recording of steam turbine spindle and cylinder expansion.

The positioner is being incorporated by Allis-Chalmers into transmitter indicators to replace some of the standard indicators used as instruments of a supervisory nature in turbine work. Other applications for the unit include the recording of water and oil levels as well as other remote indicating or recording between equipment and remotely located control boards.

Other control apparatus shown included a thermal overload relay, a heavy duty pushbutton with mounted magnifying glass to permit ready observation of the rolling-wiping contact action, a panel of seven different types of rotary control switches, and a Vari-Pitch speed changer with

LOW COST FORK TRUCK

A low cost, full-fledged fork truck, containing most of the desirable features of the Skylift series, has been announced by the Automatic Transportation Company. Characteristics are: high pressure hydraulic lift; operator of the Transrider will sit in Skylift comfort; forward and reversing lever is mounted on the driver's right; automotive type steering wheel; lift and tilt control are on the panel directly in front of the operator; and, foot brake and accelerator pedal, also of the automotive type.



THE Alliance GIANT

OVER 2,250 HORSEPOWER LIFT PER SECOND

Here's the giant of them all—the largest crane in the world! Designed and built by Alliance, this huge crane spans the Navy's mole at Hunter's Point, California, and is so big and powerful that it can easily lift a 500-ton battleship gun turret.

This is just one of the thousands of cranes developed by Alliance, for The Alliance Machine Co. builds all types—all sizes—to move heavy loads safely, quickly, and easily. For economical, *extra* lifting power in your plant, always depend on Alliance.

THE ALLIANCE MACHINE COMPANY

MAIN OFFICE
ALLIANCE, OHIO · 1622 OLIVER BUILDING, PITTSBURGH, PA.
PITTSBURGH OFFICE

Built BY THE WORLD'S NUMBER ONE DESIGNER AND MANUFACTURER *of Cranes*

LADLE CRANES
GANTRY CRANES
STRIPPING CRANES
SOAKING PIT CRANES
FORGING MANIPULATORS
OPEN HEARTH CHARGING MACHINES · SLAB AND BILLET CHARGING MACHINES
SPECIAL MILL MACHINERY
STRUCTURAL FABRICATION

This rugged crane is so large that it has its own electric sub-station, aerial beacons to warn aircraft away, and a short-wave radio for communication between the operating crews.

Let READY-POWER Solve Your Trucking Problems

Ready-Power-Equipped Baker Fork Trucks Loading Semi-Trailers

Heavy loads and long hours can't stump Ready-Power gas-electric Power Units. They are designed to "take it" and built to last. They're better than good enough to handle the toughest jobs hour after hour, day after day with constant power generated right on the truck. Specify Ready-Power for your next electric truck or write for information about converting present equipment.

Visit the Ready-Power Display at Booth 435, 3rd National Materials Handling Exposition, January 10 to 14, Convention Hall, Philadelphia, Pa.

Ready-Power-Equipped Lewis-Shepard Fork Truck

THE READY-POWER CO.

3836 Grand River Ave., Detroit 8, Michigan

transparent cover to permit visitors to view the manner in which the unit can provide infinite variations of speeds through a smooth, stepless range as high as 375 per cent.

MULTIPLE HP COUPLINGS AVAILABLE IN 17 SIZES

▲ The Lord Manufacturing Company of Erie, Pennsylvania, announces a new line of multiple hp couplings from 2 to 100 hp at 1750 rpm. The complete line is now available in 17 sizes from $\frac{1}{50}$ to 100 hp at 1750 rpm.

One-fiftieth to 15 hp couplings have 15 degree torsional deflection under rated load. Sizes 30 to 100 hp have 3 degrees. It is claimed that this high

There are no bearing surfaces to chafe with this coupling.

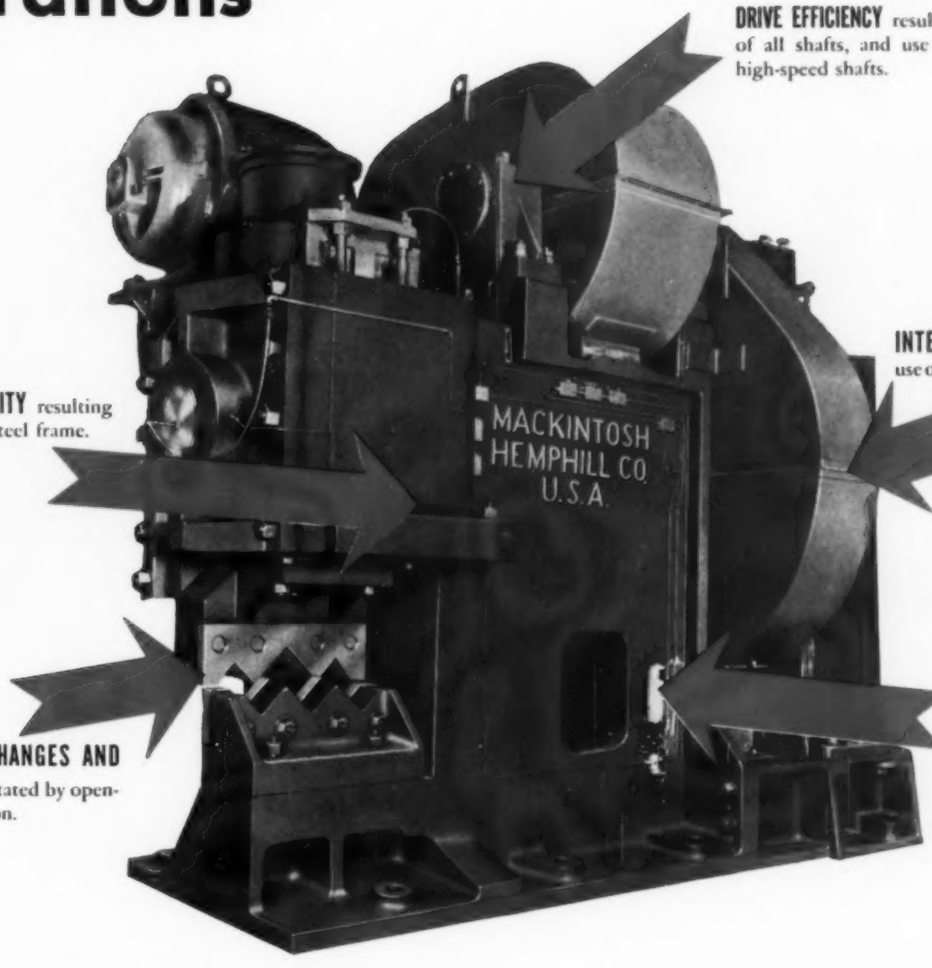
deflection gives unusual vibration isolation. Couplings will accommodate at least 2 degrees angular and $\frac{1}{32}$ in. parallel misalignment.

Neoprene flexing elements operate in shear and are bonded to steel plates. Since there are no bearing surfaces to chafe, couplings are permanently quiet, they require no lubrication and they are unaffected by such abrasives as emery, sand, crushed rock or metal particles.

CANADIAN PLANT BUYS OXYGEN MAKING UNIT

▲ Using oxygen by the ton, is the latest development in the industrial application of this gas, states the Canadian Liquid Air Company, Limited, which has recently received an order from the International Nickel Company of Canada, Limited, (Copper Cliff, Ontario) for an "Oxyton" to produce 300 tons of oxygen per day. These units are huge oxygen

High-speed cut-off shears pace production in continuous forging operations



DRIVE EFFICIENCY results from outboard support of all shafts, and use of Timken bearings on high-speed shafts.

INTEGRAL POWER assured by use of double-helical gear train.

OVERLOAD CAPACITY resulting from heavy cast steel frame.

POSITIVE LUBRICATION with automatic pressure system for bearings, and gearing in enclosed oil-tite case.

RAPID KNIFE CHANGES AND ADJUSTMENT facilitated by open-throat construction.

Designed to prevent lags in the cut-off operation in modern high-speed forging practice, Mackintosh-Hemphill Shears embody the essential features for maintaining continuous production cycles.

Manufactured in six sizes, with capacities ranging from 150 to 1250 tons, Mackintosh-Hemphill Shears can be operator-regulated to conform to the cut-off requirements of automotive and industrial forge shops, and cropping and dividing operations in continuous bar and billet mills.

The high production rate and all-'round flexibility of Mackintosh-Hemphill Shears result from these important advantages—

(a) Overload Capacity (b) Drive Efficiency (c) Integral Power (d) Rapid Knife Changes and Adjustment (e) Positive Lubrication

Whenever cut-off operations must be geared to high-speed forge shop or continuous bar mill practice you'll find that Mackintosh-Hemphill Shears can set the production pace.

MACKINTOSH-HEMPHILL CO.

PITTSBURGH AND MIDLAND, PA.

Makers of the Rolls with the Red Wabblers

OTHER MACKINTOSH-HEMPHILL PRODUCTS INCLUDE: ROLLS . . . STEEL AND SPECIAL ALLOY CASTINGS . . . COMPLETELY INTEGRATED STRIP MILLS . . . HEAVY DUTY ENGINE LATHES . . . THE NEW MACKINTOSH-ABRAMSEN STRAIGHTENERS . . . IMPROVED JOHNSTON PATENTED CORRUGATED CINDER POTS AND SLAG HANDLING EQUIPMENT . . . SHAPE STRAIGHTENERS . . . SHEARS . . . LEVELLERS.

plants for producing oxygen in large volumes for chemical, metallurgical and other industrial applications.

SUSPENSION KEEPS MAGNET FACE LEVEL

▲ Throughout the steel industry today, 55 in. and 65 in. electric lifting magnets are used to lift huge coils of finished strip steel weighing up to 30,000 lb. A very important feature in the moving of finished coils of strip is the fact that the magnet must be set down absolutely level, or else bent and torn edges will result.

The Downtown Company has produced a new improved suspension which is guaranteed to keep the face of the magnet level at all times. These suspensions made of alloy steel and heat treated, are at least twice as strong as ordinary chains and do not need periodic annealing.

Because of a specially designed locating plate the three legs are kept at 120 degree separation. This 120 degree centering or locating plate eliminates friction at the ring and in the magnet ears. With the resultant minimum amount of wear, these chains have a longer life, lasting at least three times longer than ordinary iron chains.

HAYS
CAN SHOW
YOU
HOW...
HAYS
INSTRUMENTS AND
CONTROLLERS FOR
HEAT TREATING FURNACES
Indicating · Recording · Controlling
INSTRUMENTS
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FOR EVERY
NEED
TO IMPROVE
PRACTICALLY ANY
PHASE OF STEEL
PROCESSING, TO CUT
FUEL AND LABOR COSTS
The bulletin illustrated is not just a piece of sales literature but a complete 24 page treatise on the instrumentation and automatic control of steel making and heat treating furnaces. You'll want a copy for your reference files, want to profit from its practical, authoritative information.
And remember as you read it, Hays engineers are thoroughly qualified and ready to work hand-in-hand with you in solving your own specific instrumentation and control problems . . . without obligation.
Write for your copy today . . . Ask for Bulletin No. 48-750 (covering heat-treating furnaces). Companion edition covering open-hearth furnaces will also be included.
Steel that's better, with more uniform grain structure . . . maximum production because of continuous equipment performance . . . fewer rejects . . . lower fuel, maintenance and labor costs—these are advantages you can count on when you use Hays instruments and controls for:
Annealing
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For indicating and controlling:
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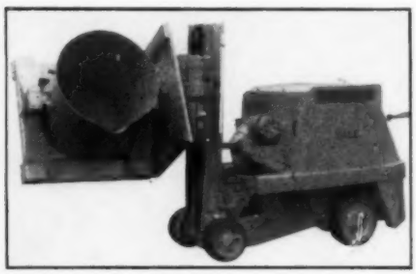
Inquiries invited on any of these specific applications.
The HAYS CORPORATION
Since 1901
COMBUSTION & INDUSTRIAL INSTRUMENTS & CONTROL
MICHIGAN CITY, INDIANA, U.S.A

ROTOR LADLE FOR ELECTRIC FORK TRUCKS

▲ Yale and Towne announces its new rotor-ladle attachment for foundry fork trucks. The new 6000 lb capacity truck and ladle was designed to transport rapidly hot molten metal from cupola to pouring-floor and to pour molten metal without having to remove the ladle from the truck. To accomplish this purpose a 360 degree rotor was developed with two speeds, the slower speed giving added control



when actually pouring the metal. In actual operation the ladle is picked up by means of forks (note the ladle base is designed for 4-way pickup), lifted to desired pouring height, and rotated to pour as desired.

The truck used in this application is an end control fork model of 54 in. wheelbase, 83 in. mast height, and 45 in. overall width. The truck has a grade clearance of 3½ in., and a turning radius, outside edge of truck with 22 in. long forks, of 96 in. Turning radius of the inside edge is 39 in. The truck has a speed of 4 mph under full load, 5½ mph empty, and 2 mph loaded up 10 per cent grade. Mast tilts 20 degrees to center the load.

The 4150 lb capacity ladle is 34½ in. in diameter by 39 in. in height.

TREATING CHEMICAL FOR ALUMINUM SURFACES

▲ There is a new surface treating chemical for aluminum which produces a protective coating in an extremely short time, usually 2 minutes

Would You Like 100 Tireless Hand·Chippers For Your Billet·Shed?

IT'S A MAN·KILLING JOB . . .

LET THE BILLETEER DO IT . . .

One hand chipper can remove a 12" chip in 60 seconds of ear-splitting, grueling work, whereas . . .

A Bonnot Billeteer operator removes a 12" chip in 2 seconds, as the 45-ton machine responds to his finger-tip control. Electric and hydraulic power activates the carriage, roll-table, chucking, turn-over, feed and turnout units. There's practically NO OPERATOR FATIGUE—no let-up in the steady output.

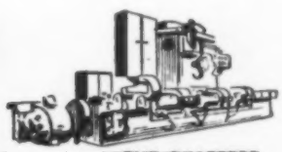
Safety-wise, a recent survey revealed that in 490,000 Billeteer hours of operation, only one man was involved in a disabling accident—A TRULY-TERRIFIC BILLET-SHED SAFETY RECORD.

MEN LIKE TO OPERATE BONNOT BILLETEERS. They decrease employee turnover in your billet-shed and boost efficiency and output.

Write today for complete information. A Bonnot engineer will give your inquiry his personal attention.

Engineered for Improved Production

The Bonnot Co.
STEEL EQUIPMENT DIVISION
CANTON 2, OHIO



THE BILLETEER

ALSO MANUFACTURERS OF SAWING · CRUSHING · PULVERIZING & MIXING EQUIPMENT

MEDART MULTICYCLE

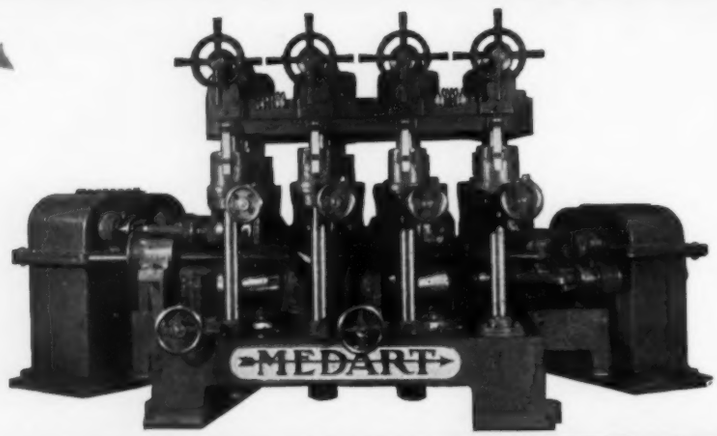
PIPE AND TUBE STRAIGHTENING MACHINE

"6 in 1"

SIX POINTS OF SUPERIORITY IN ONE

1. MULTICYCLE STRAIGHTENING—Two bending rolls impose duplex straightening cycles on workpiece insuring end to end straightness.
2. POSITIVE AND SYNCHRONIZED FEED—All four feed rolls are driven insuring positive synchronized feed and torque balanced around neutral axis of workpiece.
3. THE WORKPIECE LEVEL—Maintains one feeding level for all sizes of pipes or tubes—eliminates need of adjustable entry and delivery tables.
4. NO GUIDES—Horizontal position of the six rolls with balanced torque eliminates requirement for guides.
5. SINGLE MOTOR—All four driven rolls powered from a single motor, for synchronization and economy.
6. NO BEVEL GEARS—All gears enclosed in cases and running in oil, for sure trouble free operation.

"Patents make Jobs"



MANUFACTURING ENGINEERS OF COMPLETE TRANSMISSION EQUIPMENT AND SPECIALIZED MACHINERY

MEDART

THE MEDART COMPANY · 3500 DE KALB ST., ST. LOUIS, MO.

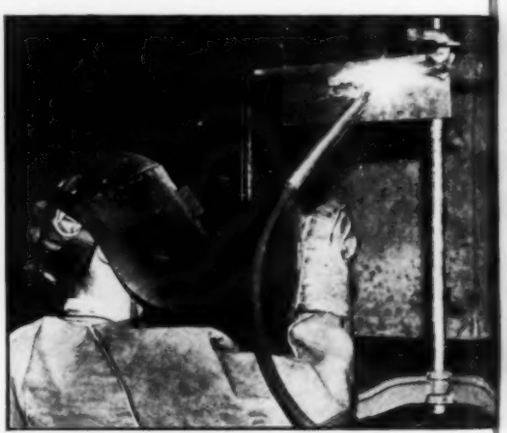
or less. This chemical can be applied by dipping, spraying (in a power washer), or brushing the aluminum parts. It is called "Alodine" and was developed by the American Chemical Paint Company.

Dipping parts into a tank containing the "Alodine" bath, for example, requires but 2 minutes for the formation of an effective coating. Spraying the work in power spray washer equipment reduces this short time still further so that an excellent coating, iridescent in color, forms in about 20 seconds. When the chemicals are brushed on large surfaces the coating time ranges from 1 to 5 minutes.

However, even in these brief processing periods, a coating of remarkable protective properties is formed.

Alodized aluminum compares favorably in its ability to anchor paint and stop corrosion with the best surfaces produced in even the most complicated processes.

NEW WELDING PROCESS

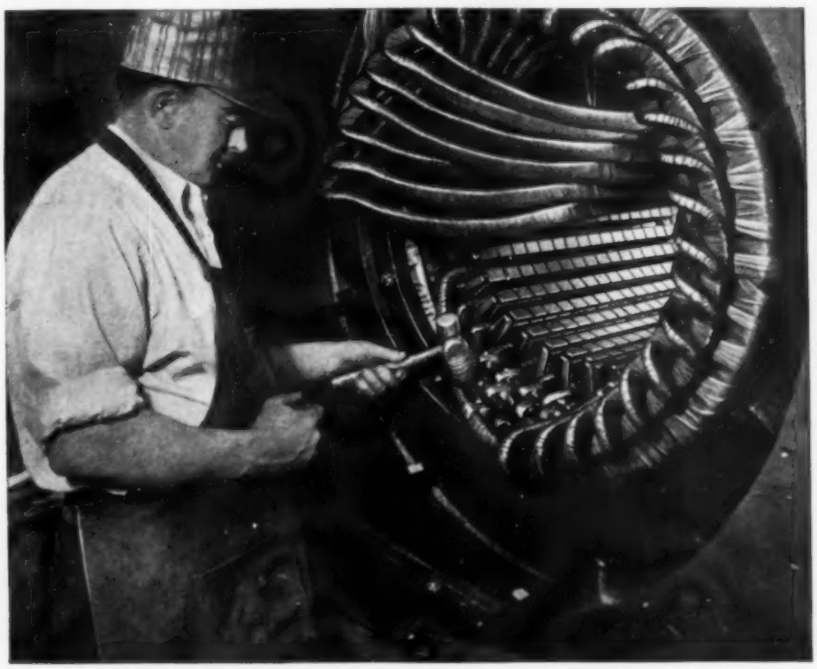


Air Reduction Sales Company has just introduced a phenomenal welding process. A product of their research laboratory, this new welding method will be known as the "Aircomatic" process. It may be used for welding heavy sections of aluminum and aluminum alloys at wire feed speeds ranging from 100 to 300 in. per min.

Essentially this process is a form of gas-shielded, metal arc welding but the conventional non-consummable electrode has been replaced by a continuously fed, consummable wire. This wire is fed to the work through the barrel of a welding "gun" as illustrated. The filler metal carries welding current and an arc is maintained between the end of the wire and the work. Power is supplied from a standard d-c welding generator and argon is used as the shielding gas.

According to the manufacturer, these units are now coming off the production line and will be generally available around the end of this year. The application of the process to metals other than aluminum is now under development.

to help you... beat motor heat!



When overwork and ambient heat keep motor temperatures up, burnouts can be a constant threat to operation. To beat motor heat — to prevent frequent motor overhaul — insist on Deltabeston* magnet wire for every winding job.

To help you beat the particular heat conditions your motors have to meet, Deltabeston is built in types for all high-temperature conditions up to 200 C. Made of purified asbestos, firmly bonded to high-conductivity copper, Deltabeston magnet wires are flexible for easy winding, heat- and moisture-resistant for long service. Deltabeston magnet wires are manufactured in all sizes and shapes.

Whether you do your own rewinding or send it to an outside shop, always specify heat-beating Deltabeston magnet wire to beat motor heat.

To help you select

Now, to help you select the proper magnet wires for your heat problem, an informative 20-page booklet is ready for mailing. It contains information on the heat-beating Deltabeston line and a handy selector chart. Just fill out the coupon, and mail it to us for your free copy.

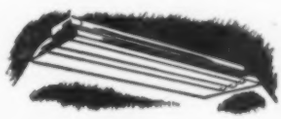
**Trade-mark Reg. U. S. Pat. Off.*

GENERAL ELECTRIC

HI-AMBIENTS

Practical product suggestions from your Deltabeston Distributor

FOR FLEXIBLE LEADS . . . on heavy apparatus that involves hot work, such as electric furnaces, cranes handling hot metals, and the like, Deltabeston motor lead cable, YK-2253, is a popular choice. Insulated with an impregnated wall of felted asbestos and asbestos braid, it resists heat, flame, oil, and corrosive vapors up to 125 C (257 F).



FLUORESCENT FIXTURES . . . need heat-resistant wiring in and around the ballast. For those located in hot, humid places, *all* the wiring should be heat resistant. Why not make your installation with the same type of Deltabeston wire which ballast and fixture manufacturers use?

WIRING JET PLANES . . . may be a long way from your business, but the choice of a Deltabeston aircraft wire for this extra-severe duty helps to explain why so many folks turn to us for solutions to "impossible" insulation requirements.

DELTABESTON
Wires and Cables
built to beat the heat

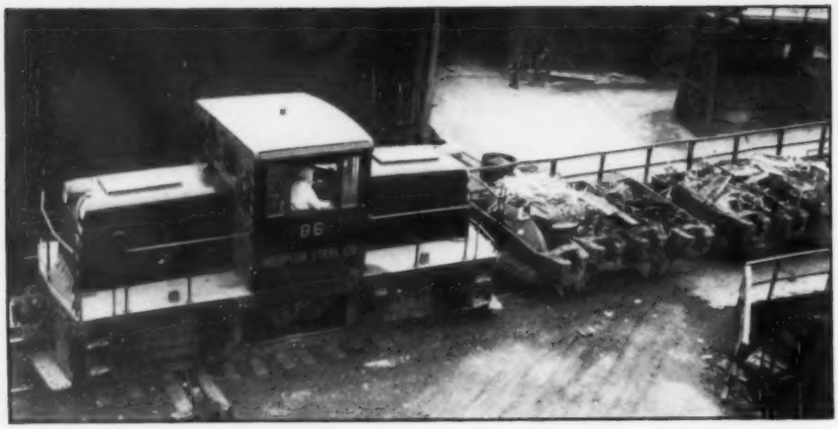
Section Y6—1146
General Electric Company
Bridgeport 2, Connecticut
Please send me the new, free booklet on Deltabeston magnet wires.

Name_____ Title_____

Company_____

Address_____

City_____ Zone____ State_____



All the new locomotives work 24 hours a day, seven days a week, with two exceptions. One 1000 hp unit works 16 hr a day, seven days a week, and one 50-ton unit is used as a standby.

DIESELS DO BETTER THAN STEAM LOCOMOTIVES

▲ Seven American Locomotive Company, General Electric diesel-electric units are doing 25 per cent more work than nine steam locomotives did previously at the Weirton Steel Company, Weirton, West Virginia. In handling switching operations, three G-E diesel-electrics are reported to do the work of four steam engines.

Weirton has 56 miles of intra-plant track with grades ranging up to a maximum of fifteen per cent. Until early 1945, when the first of the new locomotives arrived, all operations were performed with 14 coal burning locomotives. These have been replaced by three 660-hp, five 1000-hp and five 50-ton diesel-electrics. The 660-hp and 1000-hp units handle the switching of incoming and outgoing freight cars to and from the connecting main line railroads, while the smaller ones each have a special assignment in yard transfer and switching.

In two places in the yard, one diesel-electric is handling in one trip the work that it took a steam engine two trips to do. Availability of the diesel-electrics is high as compared with steam—97 per cent to approximately 60 per cent.

Until the new units were placed in operation it had always been necessary to withdraw a locomotive from the switching yard to replace a locomotive undergoing repair.

WARREN FURNACE USES HIGH TOP PRESSURE

▲ Conversion of the huge Warren, Ohio, blast furnace of Republic Steel Corporation to "high top pressure" operation has been completed and the furnace is back in production following a 10-day change-over shutdown.

It is expected that under the new operating technique production from the furnace now rated at 1275 tons per day may increase to 1500 tons. In that event, there is little doubt that the furnace will be one of the largest tonnage producing furnaces in the United States, despite the fact that structurally it is no larger than any other blast furnace now producing in this country.

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MINIMIZE EMBRITTLEMENT with Rodine®

A grade of "Rodine" is available to more completely prevent embrittling wire and other products in pickling. It does the same thorough inhibiting job so long and so generally associated with "Rodine" and efficient pickling.

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AMERICAN CHEMICAL PAINT COMPANY

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Manufacturers of Metallurgical, Agricultural and Pharmaceutical Chemicals

How you can CUT GRINDING COST AND IMPROVE ROLL FINISH *simultaneously*

Reports from users indicate that with the latest type Farrel Heavy Duty Roll Grinder they are able to cut roll grinding time substantially. At the same time, they obtain rolls with a perfect surface free from marks of any kind, either straight or with concave or convex contours ground to exact symmetry and accuracy. Faster grinding means increased productive capacity of the machine and lower labor cost per roll ground.

In addition, rolls ground by Farrel Heavy Duty Roll Grinders have longer life because the exceptionally smooth and vibration-free action in roll, wheel and traverse drives means less metal has to be removed to clean up a roll in roughing and finishing operations. This is a vital factor in reducing the frequency of roll replacement and, consequently, the cost of new rolls.

This *NEW*, 28-page bulletin shows in text, photographs and diagrams how the performance of these machines is achieved. Features described in detail include: Automatic crowning and concaving device . . . long-wearing inverted V carriage ways . . . smooth headstock drive by adjustable speed motor through multiple V belts . . . automatic lubrication of all vital moving parts . . . vibrationless carriage traverse . . . centralized control of entire grinding operation.

Write for your *FREE* copy of Bulletin No. 115.

FARREL-BIRMINGHAM COMPANY, INC., ANSONIA, CONN.

Plants: Ansonia and Derby, Conn., Buffalo, N. Y.
Sales Offices: Ansonia, Buffalo, New York, Boston, Pittsburgh, Akron, Chicago, Los Angeles, Tulsa, Houston

FB-457

Farrel-Birmingham

1848 FARREL CENTENNIAL 1948

The pressure blowing technique was perfected by Republic Steel in cooperation with Arthur D. Little, Incorporated, shortly after the recent war. Greater output of a blast furnace is obtained by increasing the amount of air blown into it and at the same time controlling the exhaust from the furnace so that higher than normal pressure is built up within it. This technique reduces the velocity of gas through the furnace and less fine iron ore is blown out of the furnace than in normal operation despite the fact that greater volumes of air are used. Because the production of a furnace is directly related to the quantity of air blown into it, increased iron tonnages result. Coke is burned more efficiently and the quality of the iron is more uniform.

During the shutdown period a number of changes in the furnace top were made to permit a tighter seal between the bell and hopper through which the iron ore, coke and limestone are charged into the furnace. In addition a new turbo blower to provide air for the furnace has been installed. This blower, the largest blast furnace blowing engine ever constructed, can provide 125,000 cu ft of air per minute at pressures up to 40 lb psi.

Republic is now using pressure blowing technique in blast furnaces in Cleveland, Chicago and Youngstown, and will use it very shortly on a furnace at Buffalo. Experience to date shows that output of furnaces using this technique can be increased by 20 per cent or more if sufficient blowing capacity is present.

The Warren furnace was built in 1919 and completely rebuilt and enlarged in 1929 and 1939. It was last relined in 1945. The volume of the interior of the furnace is 45,460 cu ft. At one time it was regarded as structurally the largest furnace in the world, but since has been exceeded by two or three more recently constructed blast furnaces.

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GAS
FASTER HEATING
UNIFORM TEMPERATURES
GREATER FLEXIBILITY
WITH THE
BLOOM
TEMPERED-FLAME BURNER
The unique patented design of this gas burner produces a flame which is very stable. The stability of the flame is not affected by extreme ranges of reducing or oxidizing air adjustments.
Outstanding results have been produced by the use of this burner on Car type Annealing Furnaces. Furnace temperatures as low as 400° F. and as high as 2450° F. can be produced without difficulty.
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ENGINEERING CO., INC.
857 W. North Avenue
Pittsburgh 12, Pa.

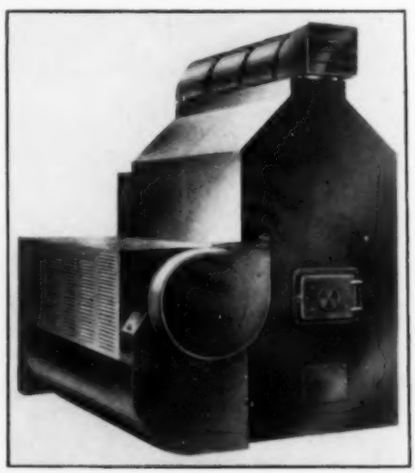
COAL-FIRED HEATER FOR INDUSTRIAL PLANTS

▲ The shortage of various types of fuel in different parts of the country has led to the development of a coal-fired warm air space heater that can be easily converted for firing with gas or oil.

The new unit, produced by Dravo Corporation is described as the answer to the problems that confront the managers of factories, foundries, garages, warehouses and other industrial and commercial establishments when certain fuels are available in limited amounts during the winter. It supplements the present line of "Counterflo" heaters that are fired either by oil or gas.

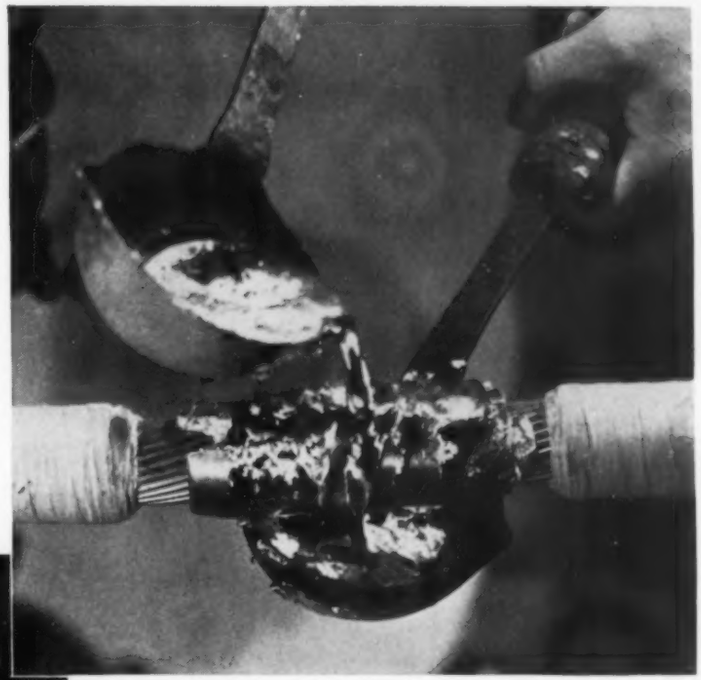
One of the chief features of the unit, besides its fuel convertibility, is the

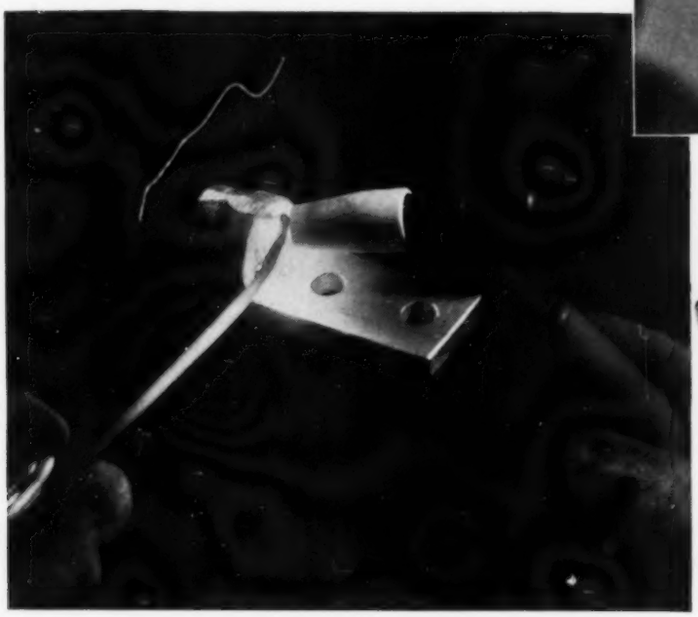
This coal-fired heater can be converted to gas or oil firing.

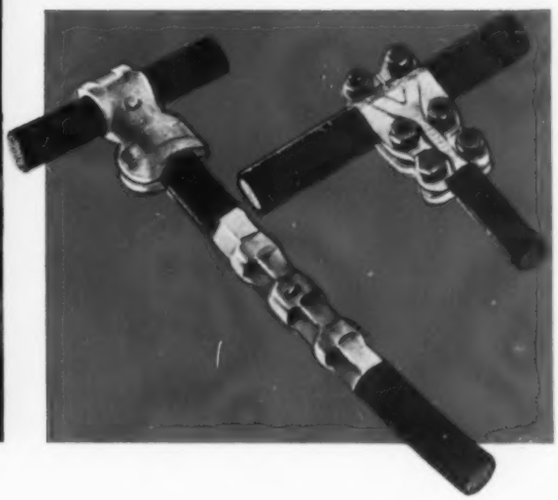


Q ***What about joints and terminals with ALUMINUM conductor?***

A ***Use mechanical, soldered, or welded connections.***







A wide range of mechanical connectors is available for use with aluminum. They're fast and require only standard tools. Generous contact area and high pressures are essential for best results.

Soldered joints are easy with Alcoa Solder and Alcoa Flux. Solder flows evenly into the joint at normal soldering temperatures, tins easily, makes a sound termination. Alcoa Flux is noncorrosive—need not be removed after soldering.

Shielded argon-arc welding produces clean, conductive terminations quickly on big jobs where many terminations are to be made in one area. The weld is efficient electrically and mechanically.

Wire and cable with Alcoa E.C.* Aluminum conductor is easier to handle throughout the job. It's lighter—as much as 50% lighter in big cable sizes. And a lot cheaper. Alcoa makes light, strong, conductive E.C. Aluminum. Leading wire and cable manufacturers draw, strand and insulate it, and sell it under their own trademarks. Ask your wire supplier about it, or write ALUMINUM COMPANY OF AMERICA, 2128 Gulf Bldg., Pittsburgh 19, Pa.

*E. C. *Electrical Conductor* Aluminum

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Only this magnet's weld is protected against damage

THE *sure* way to protect a lifting magnet's weld is to put it ON TOP OF THE MAGNET. Then, the weld is protected against hard knocks, cannot become dented in, *retains its shape indefinitely.* This means it can be turned down easily for magnet disassembly *without destroying the outer pole.*

Only Ohio PROTECTO-WELD magnets offer you this great money-saving advantage.

PROTECTO-WELD magnets are built for efficient, dependable operation on your toughest jobs. Copper coils are heavier-duty with plenty of non-cracking asphaltum insulation. Ohio Magnets operate cooler over extended periods ...lift larger loads *all day long.*

Four sizes of Ohio PROTECTO-WELD magnets are now in production: 39, 46, 55 and 65-inches in diameter. Besides 4-coil types, there are also 6 and 8-coil magnets for that extra Ohio lifting strength. For details, write today to Ohio—*25 years a leader in magnetic materials handling.*

Ohio is also a leading name in the small motor industry

Ohio MAGNETS

THE OHIO ELECTRIC MFG. CO.

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use of a stainless steel combustion chamber. It is one of the first coal-fired heaters made with a stainless steel combustion chamber. Use of this metal increases service life and eliminates a substantial amount of the customary side wall refractory.

The new model is available in two output capacities, 1,250,000 Btu per hour and 1,500,000 Btu per hour. Fuel consumption for output of 1,250,000 Btu per hour is estimated at approximately 133 lb per hour, based on coal having a calorific value of 12,500 Btu per lb.

Operation of the unit is based on the same warm air recirculation principle as the present Dravo heaters. Air is drawn into the base, passed over economizer tubes and combustion chamber and discharged through overhead nozzles. In this way, heat is held in the "working zone" and roof heat losses are reduced. The heater can be used with or without ducts, and can be adapted to bring in and heat outside air for applications that require an arrangement for tempering make-up air. It also is usable for summer ventilating and is adaptable for process drying and curing.

BETHLEHEM WINS STEEL SAFETY CONTEST

▲ First, second, third and fourth places in the 1947-1948 safety contest between the major steel plants of the country sponsored by the metals section of the National Safety Council have been won by plants of Bethlehem Steel Company, the company has announced. In addition, other awards have been made to operations of Bethlehem for outstanding work in the promotion of industrial safety.

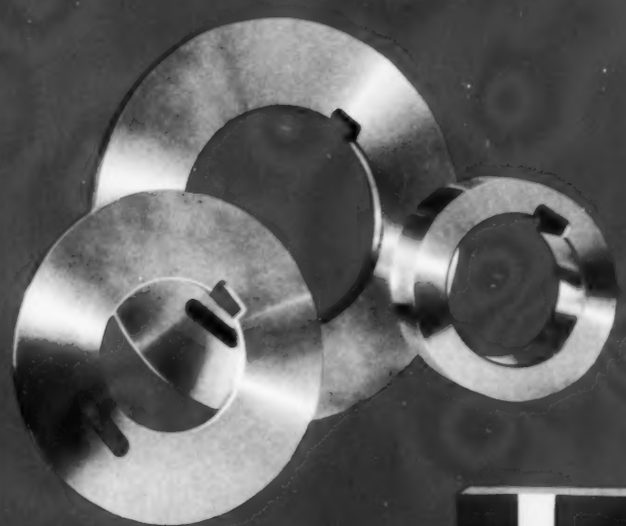
So far as can be determined, Bethlehem's winning of the four top places in the Group A, steel mills division contest of the metals section is the first time in the history of the contest, started in 1929, that this has been accomplished by any single company.

Already twice a first place winner, the company's Johnstown, Pennsylvania, plant made it three in a row by again taking top honors. The Bethlehem, Pennsylvania, plant was second. The plant at Lackawanna, New York, finished in third place and the Sparrows Point, Maryland, plant in fourth.

Awarding of places in the contest

the finest Knives obtainable

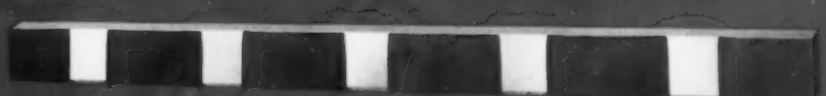
HEPPENSTALL
Shear Knives



Fine shear knives begin with fine steels—there can be no compromise on quality, no production short-cuts, for a knife is only as good as the steel that's in it!

That's why every Heppenstall Shear Knife is made from our own electric induction steels—held to the closest possible ranges of chemical composition. And each Heppenstall Knife is heat treated precisely for each specific service application.

Yes, such quality control pays off in the long run. Actual service records prove that Heppenstall Shear Knives continually deliver greater tonnage per edge, per grind and per knife. We feel safe in suggesting that they can reduce shearing costs substantially in your mill, too. Write for a quotation today to Heppenstall Company, Pittsburgh 1, Pa.



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PITTSBURGH BRIDGEPORT DETROIT

is based on the ratio of lost-time accidents to manhours worked over the twelve-month period extending from July 1 to June 30 of the next year. Group A, in which the Bethlehem plants participated, comprised the nation's major steelmaking plants.

The National Safety Council initiated the contest in order to offer a further incentive to the steel industry toward the reduction of accidents. A plaque is presented to the winner of first place at the close of the contest. Second and third place winners receive certificates attesting their standing. Certain other contestants who show marked improvement in safety records receive reduction merit certificates.

Johnstown plant, first place winner for the third consecutive year, took the honors with less than one accident per million manhours worked, improving its 1946-1947 record by 37 per cent.

Bethlehem plant, which has been four times a first place winner and four times in second place in the past eight years, placed second.

At Lackawanna plant a remarkable improvement in accident reduction was achieved, the plant taking third place by accomplishing a 50 per cent reduction in lost-time accidents.

Sparrows Point plant finished fourth, with an improvement of 30 per cent over its rate for the previous year.

In addition to these plants, Bethlehem and Pottstown fabricating works finished first in their respective divisions.

TYPE DS PEERLESS *Centrifugal* PUMPS

PROCESS SERVICES
ABRASIVE AND CORROSIVE LIQUIDS

TYPE DS
ENCLOSED IMPELLER

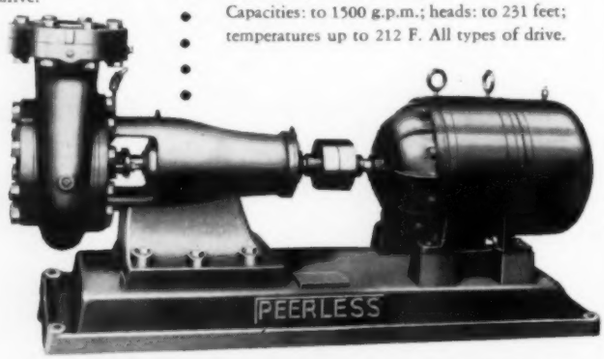
Application:

The Type DS pump is a general purpose process pump with enclosed impeller. Handles clear liquids in a variety of services and solutions which may be corrosive. Single-stage, single-end suction design. Capacities: up to 600 g.p.m.; heads up to 231 feet; temperatures up to 212 F. All types of drive.

TYPE DSO
OPEN IMPELLER

Application:

The Type DSO pump has essentially the characteristics and applications as the Type DS. However, the Type DSO utilizes an open impeller with impeller vanes on back of shroud to permit pumping of fluids with solids in suspension, brines, sludges and the like. Capacities: to 1500 g.p.m.; heads: to 231 feet; temperatures up to 212 F. All types of drive.



Write for descriptive and illustated Bulletin No. 803.

fmc PEERLESS PUMPS

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FURNACE ENGINEERS PURCHASE BUILDING

▲ Furnace Engineers, Incorporated, have purchased the office building located at 1551 West Liberty Avenue, Pittsburgh, according to Harry Dobrin, firm president. Engineering and general offices of the corporation have been located in the building since the firm was founded in 1943. The purchase price was not disclosed. Furnace Engineers design, construct and install heat treating furnaces for the steel industry.

VANADIUM OPENS ITALIAN OFFICE

▲ Vanadium-Alloys Steel Company, Latrobe, Pennsylvania, has announced the formation of a subsidiary, Vanadium-Alloys Steel Societa Italiana, in cooperation with Elli, Zerboni and Company, of Turin, Italy.

The new firm has been established to facilitate international trade in tool steel now impeded by credit and exchange conditions. It is expected that Italian business can be substantially increased by prompt delivery from warehouse stocks which will be carried in Turin, Milan and Genoa. The Italian subsidiary also will be able to render metallurgical assistance to European customers, a service which has not heretofore proved practical.

TRUCK SPEEDS PRODUCTION IN STEEL PLANT

▲ Built with capacity for picking up a load of material weighing as much as 30,000 lb on a fork or ram and to transport it at a rate of 350 fpm, a new type of power industrial truck developed recently by Elwell-Parker Electric Company, Cleveland, is finding extensive use in steel mills.

The truck's ability to handle heavy

BAKER TRUCK— unloading zinc pigs saves Hubbard & Co. 16½ man hours per car

Baker Articulated Fork Truck leaving box car with load of zinc pigs. Hubbard & Company saves 7 to 8 hours per car for each of 3 men on this operation.

At the Emeryville, California plant of Hubbard and Company, manufacturers of pole line hardware and electrical construction material, four Baker trucks cut handling costs to a minimum. A Baker Low Lift and two Baker Hy-Lift trucks expedite movement of material from process to process in the plant, while a Baker ARTICULATED Fork Truck unloads incoming material, conserves space by tiering, and speeds loading of highway trucks.

Baker Fork Truck conserves warehouse space by high tiering and speeds loading of finished products on highway trucks.

The ARTICULATED fork truck has made possible a saving of 16½ man hours per car in unloading zinc pigs. This work formerly required four men, whereas now one man operator, with the ARTICULATED Baker truck does the same work in 2½ hrs. time. Thus releasing three men for more productive work.

A Baker material handling engineer will gladly show you how to get more for your man-power dollar by mechanized handling.

BAKER INDUSTRIAL TRUCK DIVISION
of The Baker-Raulang Co.
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See us at the 3rd National Materials Handling Exposition, Philadelphia, Jan. 10-14, 1949

Baker INDUSTRIAL TRUCKS

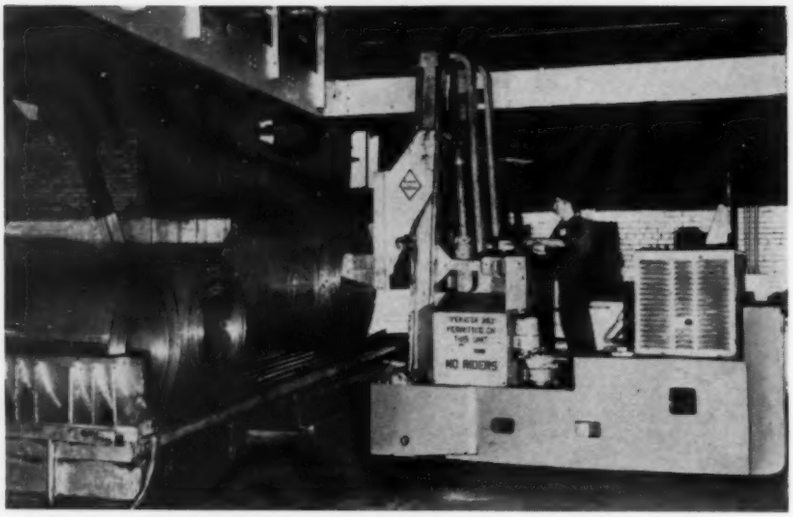


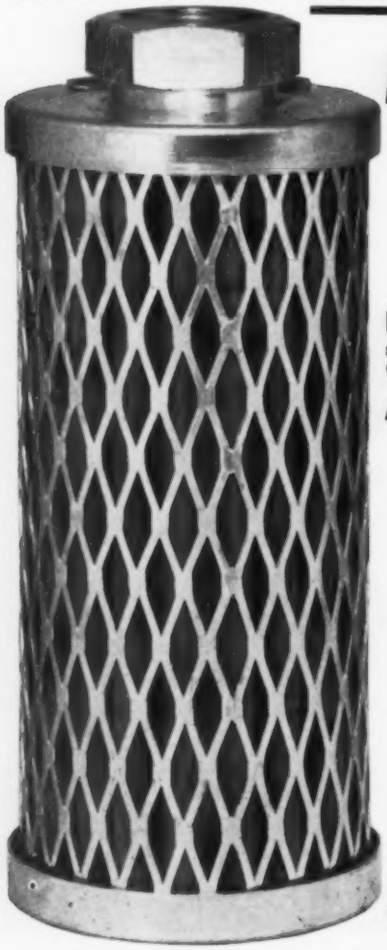
Figure 1 — The truck is shown picking up the rolls after delivery from the pickler.

loads quickly and continuously is one of its outstanding features. It can elevate a capacity load at a rate of 7 fpm, and lower it at a rate of 65 fpm. The ram customarily used for handling strip steel is 50 in. long. A fork is interchangeable with the ram, providing for a wide range of handling requirements in various departments.

One of the special advantages of heavy-duty power trucks in strip mills is their ability to maintain a flow of strip from hot-roll to pickling department or from the latter to cold-roll mills, according to schedule. They bridge the gaps between these departments in such a manner as to constitute practically part of the production system.

Long straight-line rolling as everyone knows is an essential in high-speed production. When all departments are working smoothly there is need for continuous delivery of material from one to the other. As fast as strip comes off hot mills it can be delivered to pickling department by means of power trucks, and from there after pickling to cold roll mills. This theoretically is the ideal system; but let there be a delay or interruption in one department, the areas between them serve very well for temporary storage, and power trucks run the steel in and out of storage as readily as from one department to another, keeping up the supply to pickling and to cold-rolls. Storage can serve as a bellows to assure high production of the finished product—and that is a very important function for power trucks today.

Accompanying illustrations show



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protect All Hydraulic Production Equipment

Little, yes - but it GUARDS the LIFELINE. It's constantly on the job stopping the many impurities that can soon wreck the efficiency of vital production equipment. Operational breakdowns are costly . . . even slowdowns are intolerable.

Marvel Synclinal Filters Offer:

2½ Times the Filtering Surface of Equivalent Size Units

Maximum filtration from minimum space. Standard 100 mesh synclinal insert — others range from coarse 30 to fine 200 mesh inserts. Adaptable to do any job.

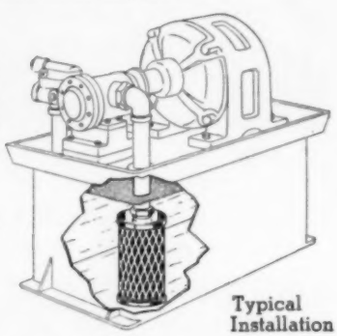
Sump Type in 6 Capacity Sizes

— 5, 8, 10, 30, or 50 Gal. per minute. Increased capacities easily obtained with manifold installations. Ideal, not only for Hydraulic Systems, but also for Coolant and other filter requirements. Marvel filters are adaptable to the precise needs of any type machine.

Simple Maintenance

Only 6 different parts. Easily disassembled, cleaned and reassembled.

Write today for Catalog No. 103 containing complete engineering data.



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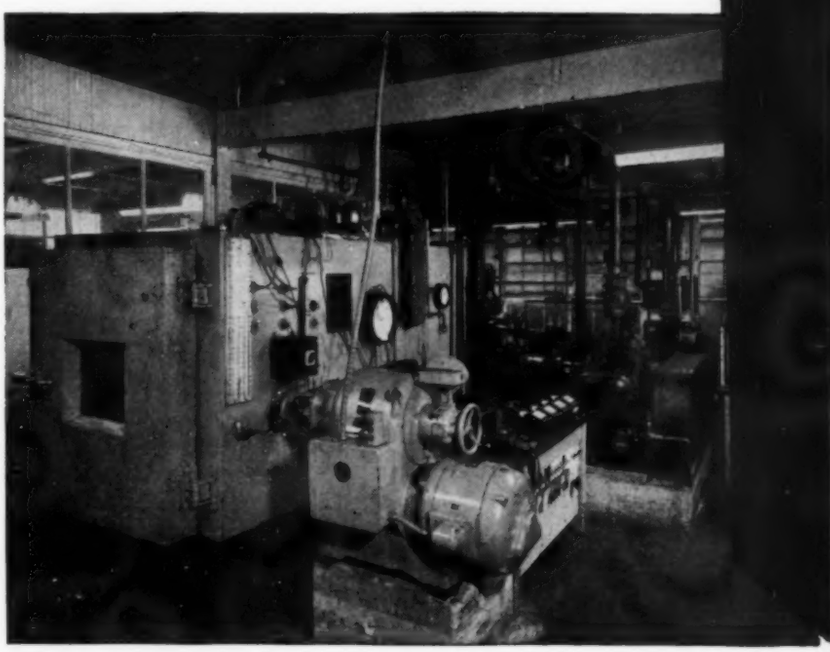
Intensive Service Testing

Variation of operating conditions — from high speeds to high altitudes — calls for diverse carbon brush characteristics. Special testing equipment such as the High Altitude Test Chamber — which simulates temperatures and air pressures at 35,000 ft.—enables Speer engineers to observe brushes at work under actual conditions . . . provide characteristics that serve best. A reason you can be sure that every Speer brush you use is fit for the job.



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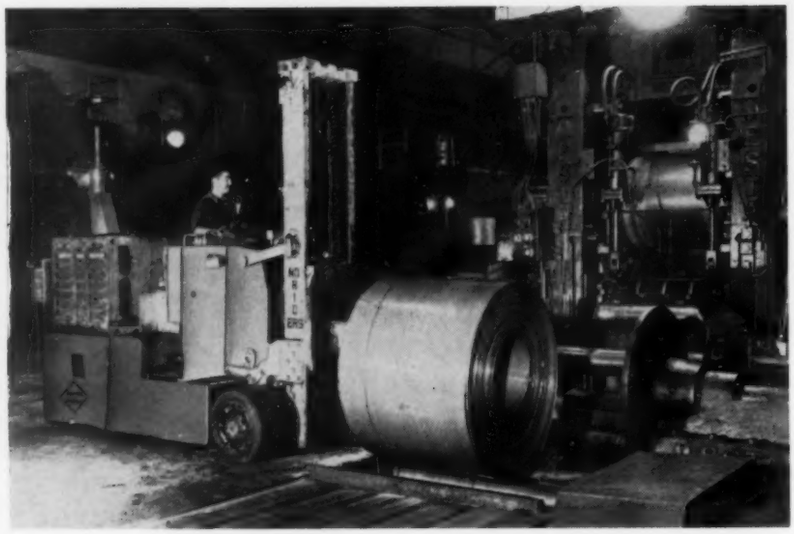

Figure 2 — A 50 per cent overload is being carried by this smaller truck.

Elwell-Parker's trucks referred to above at work in a southern Ohio steel mill. At the time these photos were made the truck was handling rolls of strip weighing 19,780 lb.

In Figure 1 the rolls are shown being delivered from pickler, on end, by roller conveyor to a roll-over device, thence horizontally on a roller conveyor to back-step where they are picked up on Model F-22 truck's ram.

The rolls are 54 x 48 and 60 in. Their weight, 19,780 lb, in this instance represents less than two-thirds of the truck's capacity.

Figure 2 shows one of Elwell-Parker's smaller trucks at work in the same mill, in this instance blithely toting one of these 19,730 lb rolls, which for this smaller model represents a 50 per cent overload. However, the big boy as well as the "littler one" is built to take it, and whenever called on will give a good account of itself. Truth is, over-capacity loading of power truck equipment in many industries is not uncommon—not because they are under-rated, but because a well-built truck has all the reserve stamina steel itself can give it.

A feature of the F-22 is its hydraulic lift with dual, low-pressure cylinders, and double dual chain carriage lift, with chain guards.

Power source is a 43-volt 24 MEH 21 Exide battery or J-60 or J-120 60 or 120-volt Ready-Power gas-electric unit. The drive motor is a heavy duty 6-pole 12-brush Class B semi-mill type fan-ventilated motor with demountable shaft. No fuses are used in power circuits. Hoist motor-pump is an Elwell-Parker heavy-duty Class

Proved by

PERFORMANCE

in the **HOT** *spots*

Soaking Pit Cranes
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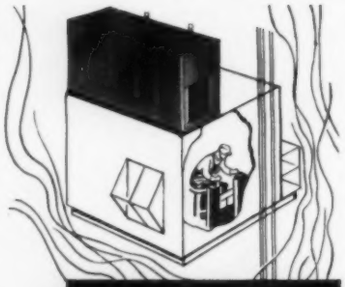

DRAVO CRANE CAB COOLERS

REPEAT ORDERS from steel, iron and non-ferrous metal producers offer proof of the outstanding results where Dravo Crane Cab Coolers reduce fatigue and improve operator performance. It's worth your while to call or wire Dravo for case history details of these applications.

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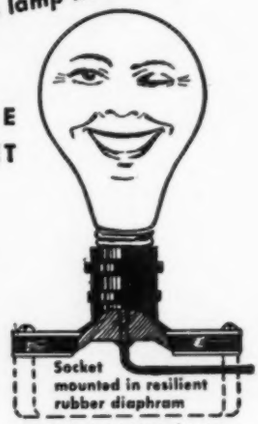
Filament Vibrosis

(Harmful vibration to lamp filaments)

PROLONG BULB LIFE WITH THIS NEW SOCKET

- **Vibration Absorbent**
- **Dust proof—Water proof**
- **Molded of NEOPRENE (won't break or shatter)**
- **New *and available***

Furnished with pigtail leads for wiring. Get complete details. Write, right now.



No. S2371—NEOPRENE Rubber lamp socket. Fits 4" standard outlet. Furnished with two protective steel mounting rings.

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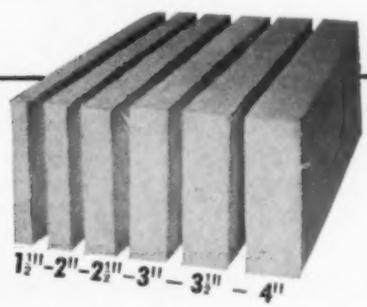
for regenerator insulation

The large size of the Superex blocks saves construction costs



Superex blocks are furnished in various standard sizes and thicknesses

• "Insulate with Superex and you make substantial fuel savings and obtain higher operating temperatures," that's what cost-conscious operators find.

Superex provides these savings year after year. Made of calcined diatomaceous silica and asbestos, it presents a formidable heat barrier. It maintains its high insulating efficiency indefinitely on temperatures to 1900° F. . . . does not disintegrate . . . retains its high physical strength . . . resists the stresses of open hearth and other mill operations.

Higher operating temperatures with Superex result from its ability to reduce air infiltration. This advantage is traced to its unique structure and low permeability.

Superex is light in weight, easily cut and applied . . . comes in convenient standard sizes or may be ordered in irregular shapes.

To help you gain the greatest savings from Superex, Johns-Manville has prepared an engineering report, "Open Hearth Regenerators—a comparison of various insulation specifications." This report indicates the economic thickness of Superex to use as related to the costs of various types of fuels. To obtain this booklet, write Johns-Manville, Box 290, New York 16, N. Y.

TO OBTAIN THIS BOOKLET, WRITE
JOHNS-MANVILLE
Box 290, New York 16, N. Y.

JOHNS-MANVILLE *First in* INSULATIONS

B 8-brush hoist motor with demountable armature shaft having asbestos and fiberglass insulation.

The power plant motor is direct connected to heavy spur gear reduction, drop forged differential to full floating drive shafts. Equal length chrome molybdenum heat-treated shafts carry heavy alloy steel sprockets and chain that drive outside wheel of each compensating trunnioned pair of front wheels. Each front drive wheel as well as idle wheel is carried on large roller bearings. Travel is accomplished through two front drive wheels and two idle wheels adjacent to the load end of the truck, and two caster-type steered wheels on axle mounted in rubber at rear. Hydraulic braking is applied to each front wheel.

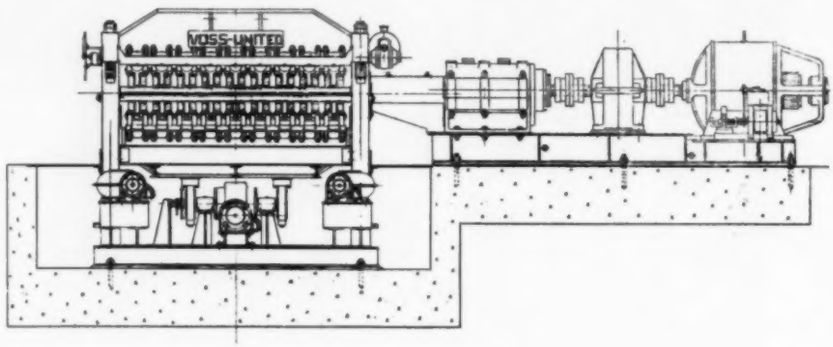
Truck control is of the full magnetic contactor type. To the right of the operator are hoist and travel indicators. Pressing either of these levers electrically starts corresponding controlled unit. There are three travel speeds forward and three reverse. Electric power steer is standard.

Weight of the truck with power unit is approximately 35,000 lb.

ROLLER LEVELER FOR STAINLESS STEEL

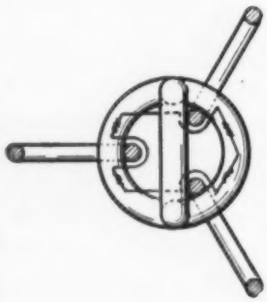
▲ Two inverted type Voss roller levelers have recently been built by Voss Engineering Company to flatten stainless steel and aluminum plates for well known manufacturers of these products.

Built into these machines is the Voss Engineering Company patented inverted type of construction in which the major control of leveling is done entirely through the lower flight of rolls. This construction does away with screwdown screws and their constant reversal of stresses, substituting an adjustable wedge instead, on which the loads are always downward, eliminating a source of troublesome lost motion. Wedges are also used to support the system of backup rollers for the top and bottom flights of work rolls. By suitably adjusting these wedges, pressure can be applied on either or both flights of rolls as required by the nature of the work being flattened.



EVERY PROBLEM HAS AN
ANSWER

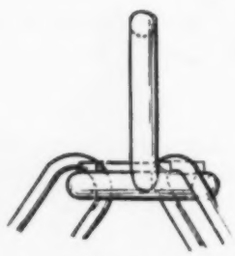
If one problem is the frequent replacement of magnet suspension chains and periodic annealing — The Downtown Company has the answer!



THE FRICTIONLESS
SUSPENSION CHAINS

1 Last up to 3 times as long as old-style suspensions.
2 Are made of heat-treated high alloy steel to eliminate periodic annealing.
3 Ring plate keeps chains separated by 120 degrees. No rubbing or twisting. Keeps magnet level.
4 The chain for 55" magnets tests to 89,000 lb.
5 The chain for 65 in. magnets tests to 115,000 lb.

Write for prices, prompt shipment from stock.

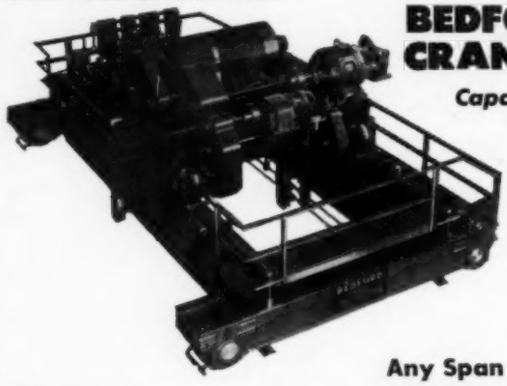


Pat. Pending

DOWNTOWN Company
1836 EUCLID AVE. • CLEVELAND 15, OHIO

CRANE BUILDERS Since 1903

BEDFORD CRANES
Capacities 5 to 150 Tons



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STRUCTURAL STEEL • STEEL BUILDINGS

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Fabricators
BEDFORD, INDIANA
U. S. A.
Gray Iron Castings

SHORT IN COST...
L-O-N-G IN SERVICE...

This MONEL Pickling Crate has been on the job for 13 years

THE Follansbee Steel Corporation of Follansbee, W. Va., wanted a pickling crate... one that would carry a two-ton load of high silicon electrical steel sheet...one that would last a long time with a minimum of upkeep expense.

They chose MONEL* as the fabricating material; chose it because of MONEL'S exceptional resistance to hot acids and its steel-like strength. And a wise choice it was, for today *—13 years later*—the MONEL pickling crate is still in service!

During war years, when ever more production was needed, the MONEL pickling crate carried a double load of armor plate: 4 tons instead of 2. Yet, even with this increased burden, the crate more than lived up to expectations.

This is but one of thousands of instances where MONEL has shown its outstanding superiority under severely corrosive conditions.

In addition to high strength and corrosion-resistance, MONEL offers *workability*. MONEL can be fabricated by ordinary shop methods without special tools or equipment. MONEL can be welded. And what is extremely important—welded MONEL seams are corrosion-resistant.

Check your own plant installations today. You may find many places where the versatile INCO Nickel Alloys can save you money. For further information, contact your nearest INCO distributor. He will gladly help with your metal selection problems. *Reg. U. S. Pat. Off.

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WHITEHEAD METAL PRODUCTS COMPANY, INC.
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MONEL
FOR MINIMUM MAINTENANCE

EMBLEM OF SERVICE
INCO
TRADE MARK

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.

The leveler built for flattening stainless steel has 23 work rolls, $2^{11}/_{16}$ in. in diameter and a 60 in. long body. There are 11 rolls in the top flight; 12 in the bottom, and each flight is backed up by a suitable number of back-up rollers operating on self-aligning roller bearings.

The leveling rolls are made from special alloy steel, hardened and accurately ground to size, with a hardness of 60 to 65 Rockwell C penetrating the roll body from $^3/_{16}$ in. to $^1/_4$ in. The roll necks run in automatically lubricated bronze bushings. The small amount of head room over the pass line in the inverted type levelers assists in the efficient handling of crane lifts when loading and unloading the feed and delivery tables at the leveler.

The stainless steel sheets for which this machine is designed have a maximum yield point of 100,000 psi, and vary in thickness from .025 in. to .168 in., with widths up to 48 in.

The main leveler drive motor is 100 hp, 850/1750 rpm, 230 volt d-c. The two roll height and one radial tilt motors are each 5 hp, 1750 rpm, 440 volt, 3 phase, 60 cycle, a-c. Operating speed, 40 to 160 fpm.

The leveler built to flatten aluminum is of similar construction, with 96 in. long leveling rolls. It is designed to handle $84^1/_2$ in. wide aluminum alloy sheets with a maximum yield point of 60,000 psi, from .035 in. to .156 in. in thickness.

PLUG-IN OUTLET STRIPS GIVE ELECTRICAL SPREAD

▲ A new plug-in strip incorporating electrical outlets at either 6 in. or 18 in. intervals, factory-wired into a continuous copper conductor system, and enclosed in 3 ft or 6 ft lengths of steel channel which can be cut to fit on the job without disturbing the assembly, has been announced by National Electric Products Corporation. This new product, when mounted on walls, baseboards, tables, or on display counters and shelves, provides a spread of electrical outlets to meet the increasing demand to "plug-in" business machines, fans, lighting or dictating equipment, electrical appliances, clocks or small power-driven tools.

HEAVY MEDIA PLANT FOR WEST VIRGINIA MINE

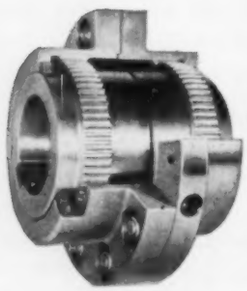
▲ Nelson L. Davis Company, engineers and contractors, have been awarded the contract for a heavy media coal processing plant for Youngstown Mines Corporation, Dehue, Logan County, West Virginia. This plant will handle 350 tons per hour of run-of-mine coal. All plus 4 in. coal will be reduced to 4 in., the $^1/_4$ in. x 0 in. will be screened from same and the 4 in. x $^1/_4$ in. raw resultant will be processed by the Davis heavy media system.

The complete new plant facilities include presizing, crushing, loading and rejected disposal. The finished product is to be used for producing blast furnace coke.

For additional information on any products advertised turn to pages 17 and 18 and use:
PRODUCT INFORMATION

REMEMBER THIS ABOUT COUPLINGS

there are gear types —and there's the WALDRON Improved Gear Type



Designed To Permit Use Of Larger Shafts and Equipment

The *improved* WALDRON gear type is distinguished from the ordinary gear types by the many extra operating advantages built into its new design — advantages that you will recognize instantly.

For ratings, service factors and other details, write for Catalog 57.

JOHN WALDRON CORP.
Main Office and Works
New Brunswick, New Jersey
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ROCKWELL FURNACES

Gas • Oil • Electric
Batch or Continuous
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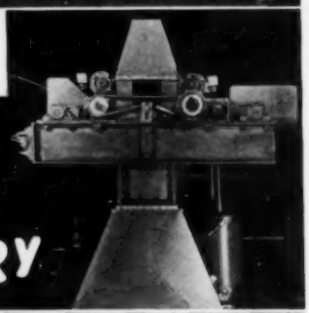
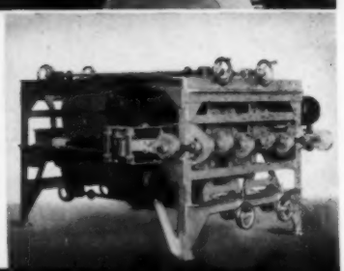
ROCKWELL SPECIAL MACHINERY

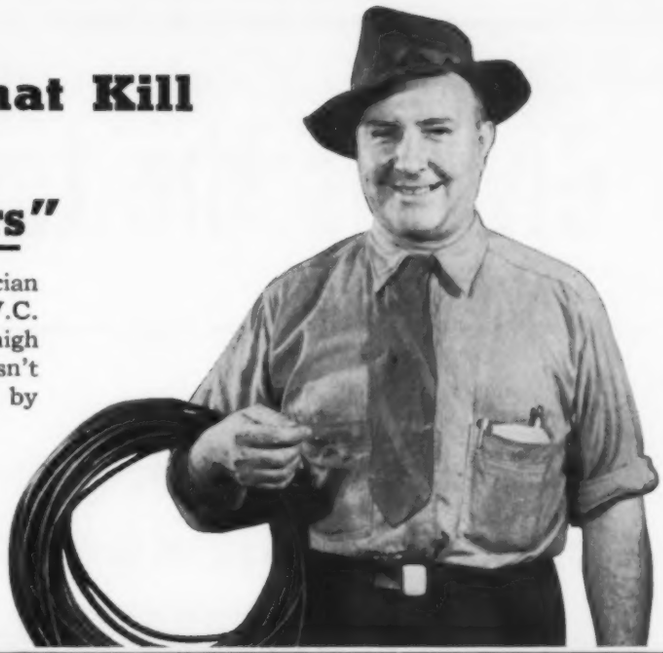


Brush Boxes
Coil Boxes
Coilers
Stitchers for Strip
Pickling Machines
Dryers
Special Machines



W. S. ROCKWELL COMPANY
244 ELIOT STREET • FAIRFIELD, CONN.

"Under Conditions That Kill Ordinary Wire Fast, This Wire Lasts Years"



Says Mr. T. F. Bannon (right) Chief Electrician at Bird & Son, "Rockbestos 600 Volt A.V.C. lighting wire withstands the baking heat and high humidity our conditions impose on it. It doesn't bake brittle, crack or flow. It isn't damaged by the constant condensation. In short, it lasts years longer under these rigid conditions than we could hope for with 'ordinary' wire. I've used Rockbestos A.V.C. for over 20 years... and it hasn't ever fallen down on a job for me yet! What electrician could ask for more?"

In the paper plant of Bird & Son, inc., East Walpole, Mass., temperatures in this paper machine dryer hood run a constant 135° to 140° F., with relative humidity often as high as 65%. Conditions like these mean a quick end for lighting wire not specifically engineered to do the toughest jobs as dependably as the easiest ones. Which is why more and more alert plant men are turning to Rockbestos for sure performance under exacting conditions.

ROCKBESTOS PRODUCTS CORP.
NEW HAVEN 4, CONN.

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PITTSBURGH ST. LOUIS LOS ANGELES OAKLAND, CAL.

Your copy of our new 96-page catalog is ready. Write for it.

ROCKBESTOS

THE WIRE WITH PERMANENT INSULATION

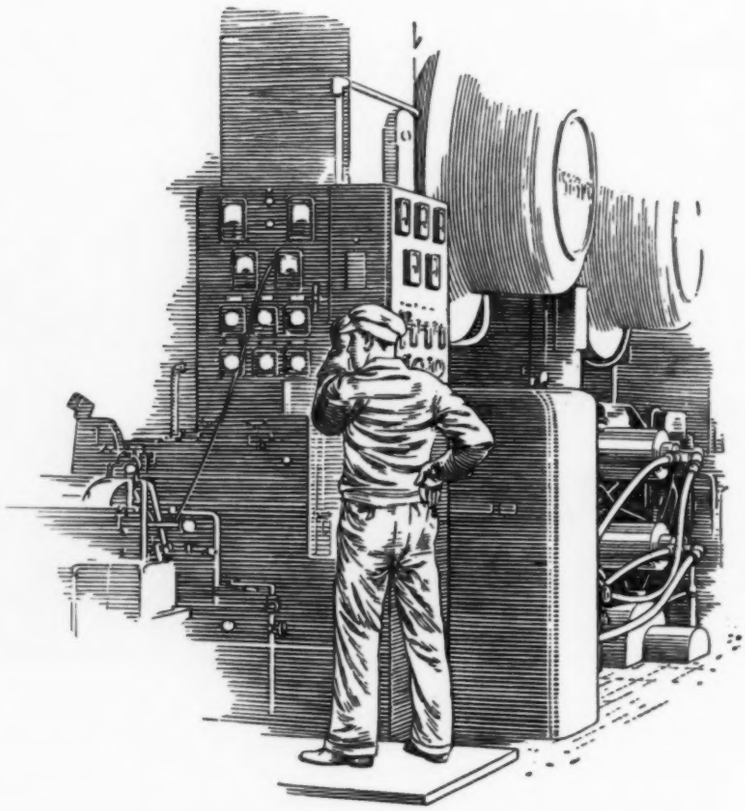
Give us the toughest bearing

You can compare the life and service record of Torrington Bearings with your best previous performance on any application . . . *right in your own mill*

Torrington Bearings are growing more and more in use and performance in the steel industry. This is due primarily to one factor . . . *demonstrated performance.*

Our approach to the design and manufacture of anti-friction bearings for heavy industry service is based on engineering skill and experience. It assures a superiority in capacity, ruggedness, precision and metallurgical characteristics that mean longer service life in any application.

To prove this to your complete satisfaction, we suggest you select the toughest anti-friction bearing application in your mill. Call in a Torrington service engineer. Arrange to run a performance test on TORRINGTON BEARINGS under your own control on your next major bearing replacement.



TORRINGTON

SPHERICAL ROLLER • TAPERED ROLLER • NEEDLE

application in your mill...

Here are the reasons why we can make these statements on the greater performance and longer service life for Torrington Bearings

For years, Torrington engineers have engaged in designing and building *all* major types of anti-friction bearings. This has included straight roller, tapered roller, spherical roller (and combinations of them), as well as ball, needle roller and many special types.

Thus, we are thoroughly experienced in working with new, unusual situations and adapting the *best* bearings design to meet exactly *each particular requirement* in any given instance. We do not try to sell or install a stock bearing in every mill simply because that is the type we make. We have stock or standard bearings that can and do fill a wide range of applications. Where conditions call for it, we are equipped to supply "custom-built" types. The true measure of economy is service—and the *best* service-per-dollar-invested is what we recommend.

That is the reason why we believe we can give you exactly the right bearing for each application.

And that, in turn, adds up to why we suggest that you try TORRINGTON on your *next* bearing job. The proof is in a demonstration—right in your own mill under conditions you *know* and can watch. You can arrange such a trial now. A phone call or letter will get it under way.

THE TORRINGTON COMPANY
South Bend 21, Ind. • Torrington, Conn.
District Offices and Distributors in Principal Cities

BEARINGS

STRAIGHT ROLLER • BALL • NEEDLE ROLLERS

43,800 HP Rolling Steel

... 24 HOURS A DAY., 5-6 DAYS A WEEK!

That's Rated HP of Allis-Chalmers Motors You See in This Hot Strip Mill Motor Room!

HERE'S HOW COMPLETELY Allis-Chalmers can equip your motor rooms. On this 68-inch hot strip mill, Allis-Chalmers motors drive the 5-stand roughing train, the 6-stand finishing train, and the roughing and finishing scale breakers.

A major part of the remaining power equipment is also Allis-Chalmers . . . the three main 6000 kw m-g sets, each driven by an 8400 hp motor . . . the auxiliary and control m-g sets . . . the rectifier unit . . . and the control.

A-C designed and built the special control for the roughing mill synchronous motors . . . for field application, inching, and dynamic braking.

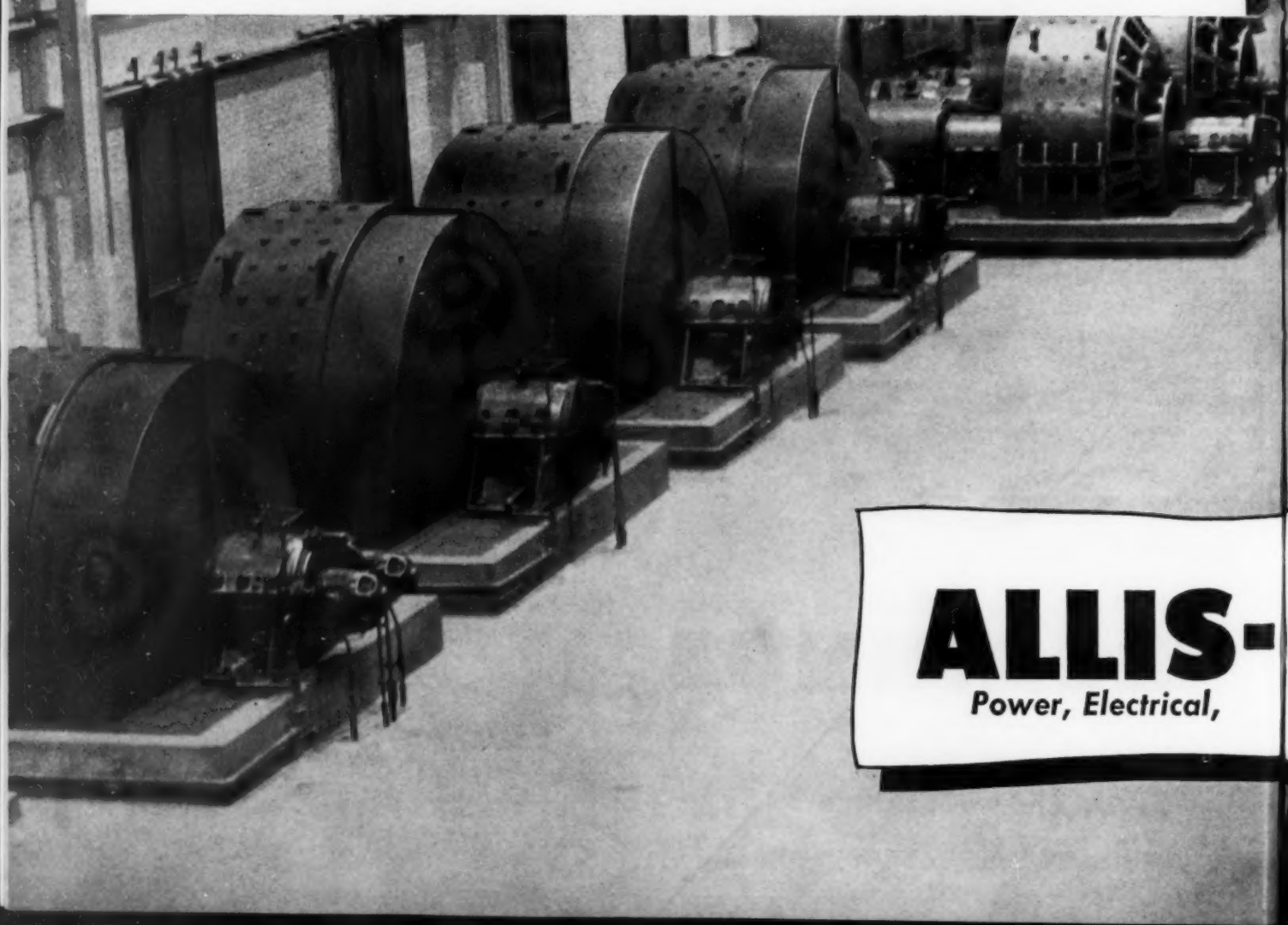
For inching, each roughing drive uses an individual m-g set consisting of three small d-c generators connected in the three phases of the main roll motor. These generators produce a 3-phase voltage at very low frequency, causing the motor to rotate at a small fraction of its normal speed.

During dynamic braking these same generators supply power to the stator, causing the amortisseur winding to produce the braking effect.

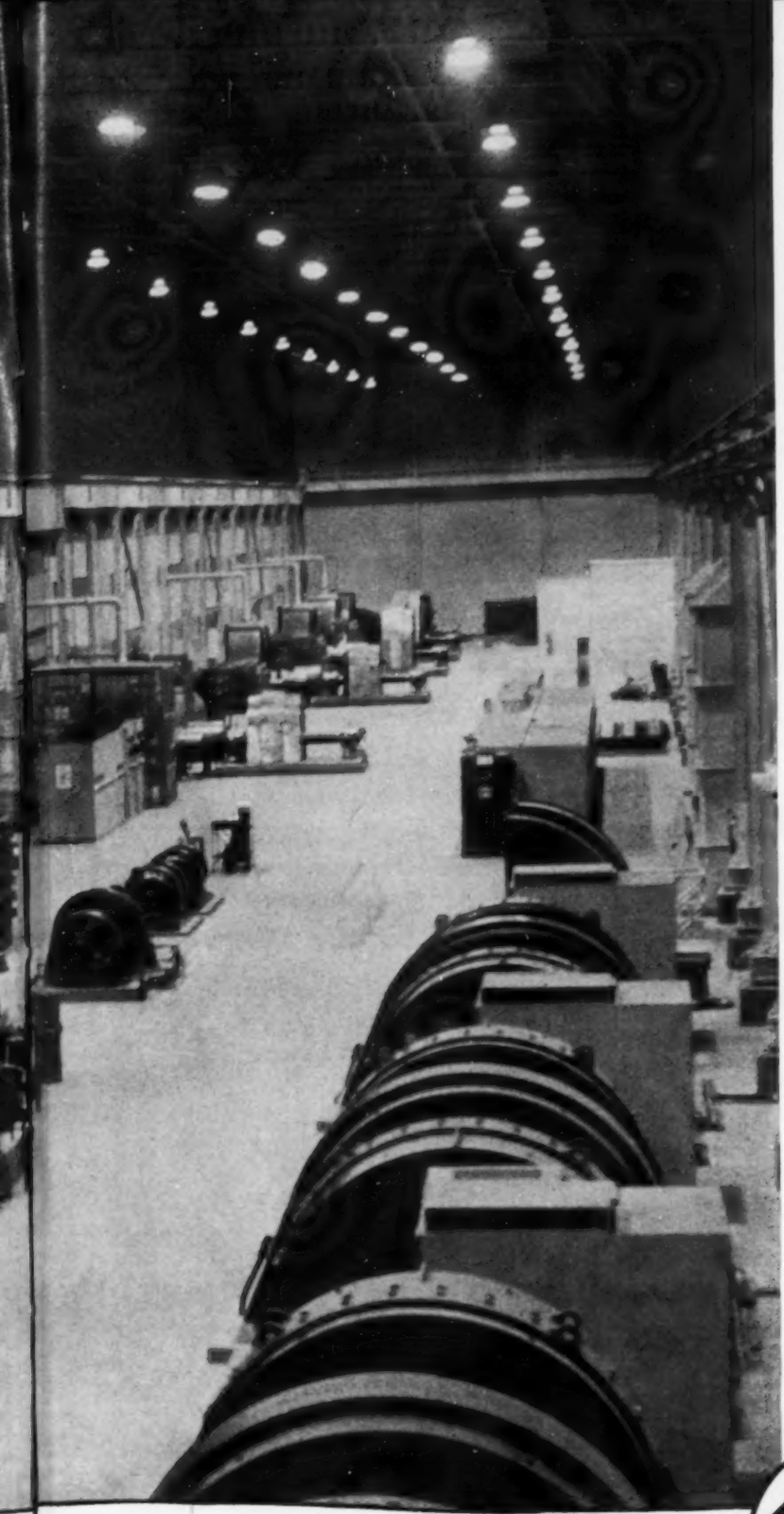
For assistance with your special control and equipment problems, call your nearby A-C office. Or write direct. A 2551

ALLIS-CHALMERS, 1020A SO. 70 ST.
MILWAUKEE, WIS.

Regulex and *Texrope* are Allis-Chalmers trademarks.

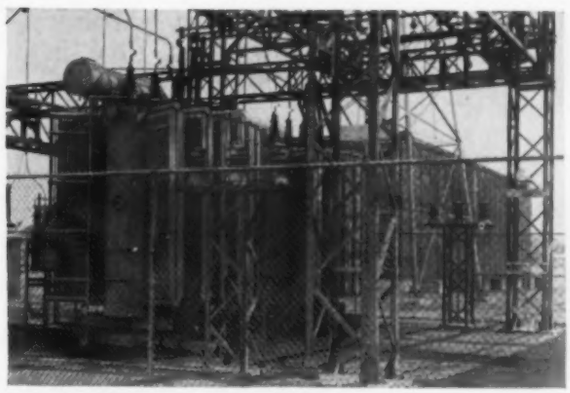


ALLIS-
Power, Electrical,



A-C Equipment Aids Continuous Steel Rolling in this Mill...in Your Mill!

MOTOR ROOM (left) equipment from rear forward includes: roughing scale-breaker motor . . . roughing train synchronous motors . . . two 750 kw rectifiers, exciters, and control . . . finishing train d-c motors . . . motor-generator sets — all Allis-Chalmers.



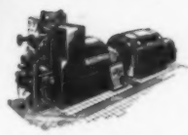
OUTDOOR SUBSTATION for the motor room has two Allis-Chalmers oil-filled power transformers, rated 15,000 kva, 34,500/6900 volts.

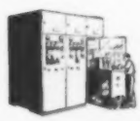
PULPIT CONTROL for both the finishing mill (left) and the roughing mill were built by A-C. The finishing mill control system includes the *Regulex* exciter that controls the 50 kw exciter for the fields of the six 3000 kw main generators. Speeds of 2000 feet per minute are recorded at the number 11 stand.

ALLIS-CHALMERS A-C MILWAUKEE

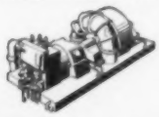
CHALMERS

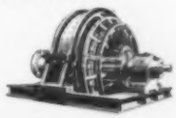
Processing Equipment for Iron and Steel



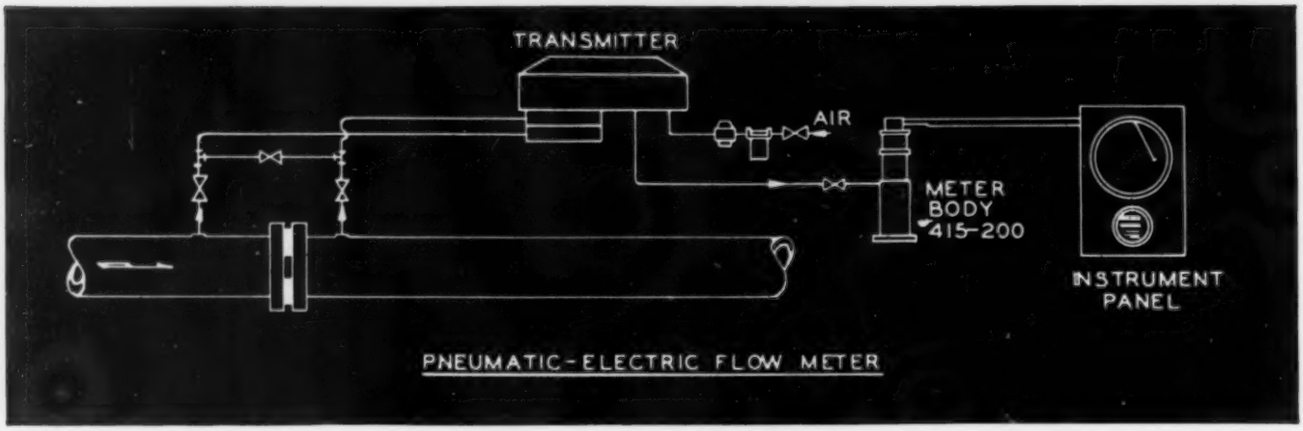


POWER & ELECTRICAL — Steam Turbines, Condensers, Water Conditioning, Power Transformers, Switchgear, Unit Substations, Circuit Breakers . . .





UTILIZATION & PROCESS — Motors, Blowers, Rectifiers, M-G Sets, Betatron, Pumps, Compressors, *Regulex* Exciters, *Texrope* V-Belt Drives . . .



The Answer to Your OXYGEN *Metering Problems!*

Here is an oxygen flow metering system that will accurately integrate the rapidly fluctuating flows encountered in steel mill operations.

CONTINUOUS INTEGRATION

The electric integrator, operating on a modified watt hour principle, is continuous, not intermittent in operation — is extremely sensitive, acceleration and retardation being practically instantaneous. It will accurately integrate the most erratic fluctuations transmitted by the highly responsive meter element.

SENSITIVE METERING SYSTEM

The flow metering system, shown diagrammatically above, is a combination pneumatic-electric system for measuring a rapidly fluctuating flow. It consists of a pneumatic transmitter, an electric meter body and any desired combination of remote reading instruments. It has been especially designed to overcome the problems encountered in oxygen flow measurement.

FIELD TESTS

Laboratory tests of the complete meter have shown an over-all accuracy within ±2% for various flow cycles, including a cycle as short as 8 seconds "on" and 8 seconds "off". Field installations checked against weighed quantity of oxygen actually delivered over six month period substantiate these laboratory tests.

WIDE RANGE

For those installations where wide ranges of flow are encountered, a Republic pneumatic-electric metering system can be installed with a range of approximately 10 to 1. By a special piping arrangement, the range of accurate flow measurement can be extended to approximately 50 to 1.

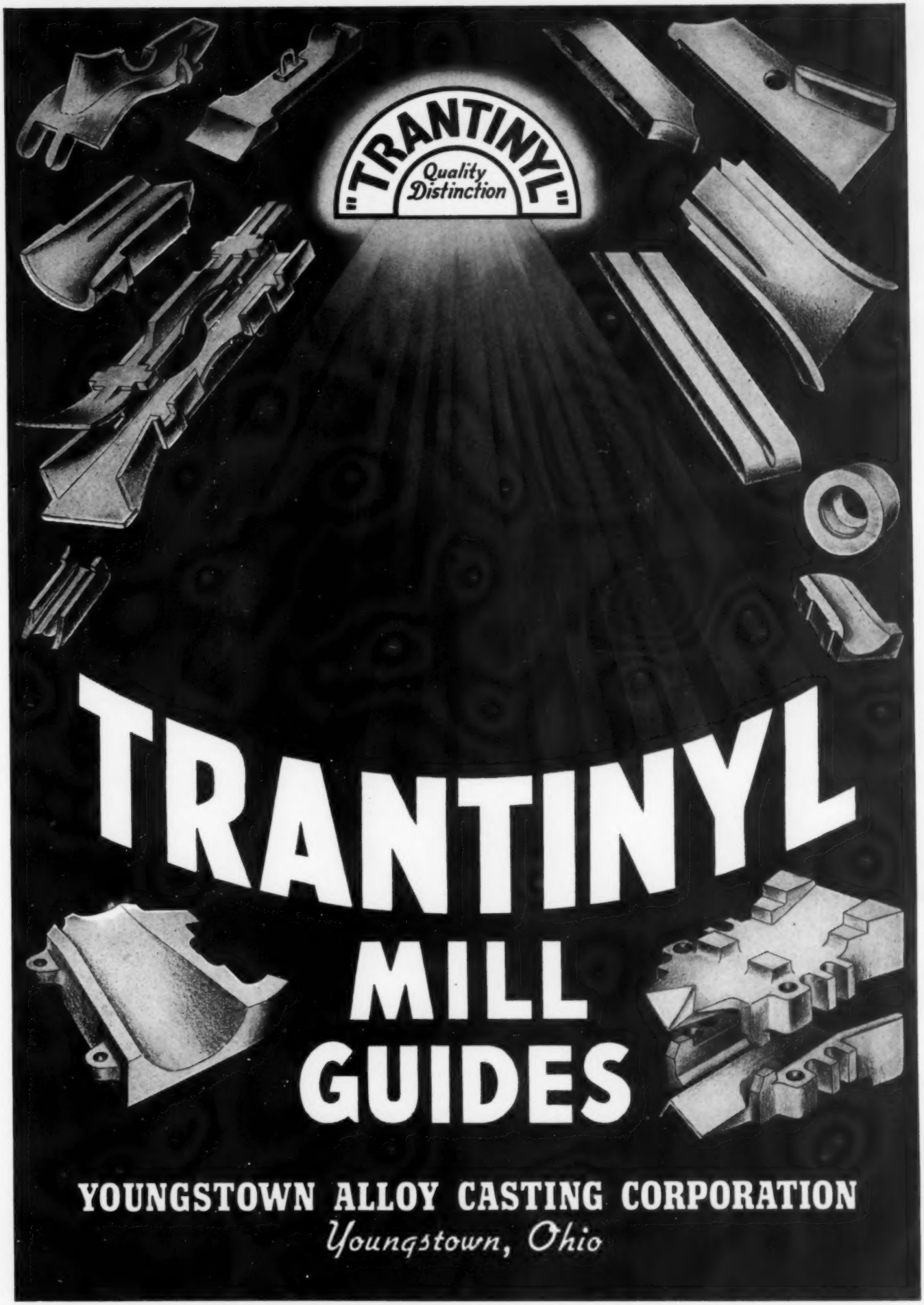
Republic Continuous Integrator

The Republic pneumatic-electric flow metering system is completely described in Bulletin No. 48-2.

Write for your copy today.

REPUBLIC FLOW METERS CO.

2240 Diversey Parkway, Chicago 47, Illinois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GUIDES
YOUNGSTOWN ALLOY CASTING CORPORATION
Youngstown, Ohio

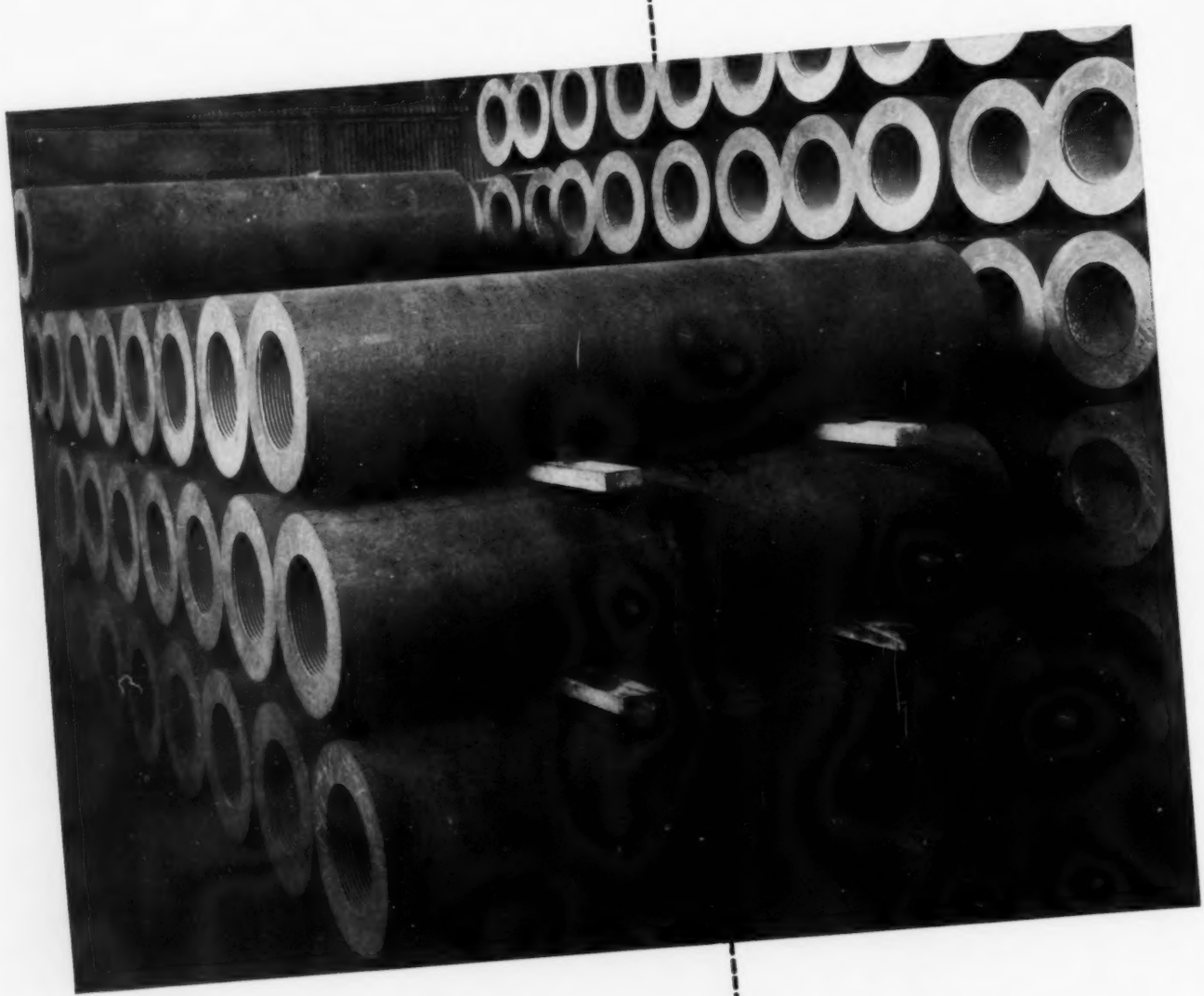
INTERNATIONAL GRAPHITE ELECTRODES

STACK-UP HIGH

TO KEEP PRODUCTION COSTS LOW

Superior performance of International Graphite Electrodes—high thermal conductivity . . . high current capacity . . . high resistance to oxidation . . . high degree of purity—assures lower cost per ton of production. All International Electrodes fully measure up to every important standard by which acceptable electrodes are judged.

Write for International's Engineering Data Book which contains valuable electrode engineering information.



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FOR THOSE WHO MUST KNOW

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- For securing any publication listed in permanent file just jot down numbers in space provided on mailing card.
- Be sure to include your name, address, title, etc., to insure speedy return.

NOVEMBER, 1948

(1) Protective Coatings

A new 12-page folder has been issued which gives expert direction on the application of cold-applied protective coatings, especially designed to prevent corrosion and deterioration. The informative material describes protective coatings, as well as giving general information on surface preparation, coating thickness, and methods of application. The various types of protective coatings made for cold application are described in detail, together with information on coverage, primers needed if any, drying time, thinners that can be used, and temperature limits. The folder presents pictures of specific applications, and outlines methods of preventing corrosion caused by industrial atmosphere, chemical fumes, moisture, corrosive soil, and heat. It also offers specialized consulting service in solving corrosion problems which are intensified by heat, humidity, continuous condensation, where uncommon chemicals are involved and where application is complicated by special operating conditions. Tar Products division, Koppers Company, Inc.

(2) Corrosion Control

The part played by corrosion control in the production of salt, and in the use of brine solutions by chemical and food processors, is described in a new 20-page booklet just issued, entitled "Salt as a Corrosion Problem." The booklet's contents are about equally divided between a discussion of corrosion problems solved by the salt industry, and equipment for handling brine solutions in the chemical and process industries. International Nickel Company Inc.

(3) Engineering Guidebook

A 20-page planning and engineering guidebook prepared to simplify and speed the layout of load center unit substations has been released. Dimensional and arrangement information enables industrial unit substation users to determine floor space and head room requirements as soon as the unit is specified. Information is given on units ranging from 100 kva to 2000 kva used widely in industrial plants for distribution at 208Y/120, 240, 480 and 600 volts having both liquid-filled and dry-type transformers. Incoming line equipment ranging from metal-clad switchgear to roof bushings is covered as well as sizes and arrangements of feeder switchgear. A number of examples are worked out to illustrate the material and to set a pattern for its use.

When used with another bulletin that is available entitled, "Check List to Simplify Unit Substation Planning," the booklet makes it possible to determine the best electrical layout for various loads, the recommended ratings and the space requirements of the equipment. (11B6895 and 11B6325A). Allis-Chalmers Manufacturing Company.

(4) Corrosive Solution Handling

A new 20-page bulletin on Model 40 Series M centrifugal Durcopumps includes their newest design features and complete exploded views of all parts. These pumps are designed and built exclusively for the handling of corrosive solutions, and every element in their construction is calculated to increase service life, ease of maintenance and ease of adjustment. Features include: Micro adjustment of impeller; replaceable shaft sleeves; patented vent ports in the impeller to relieve pressure on the stuffing box during operation; full ball bearing construction; and, non-scoring Teflon seal cages. Every pump is adaptable to an extraordinarily wide range of corrosive service, as the wet ends are available in twelve alloys and all parts can be made interchangeable. This convertibility prevents pump obsolescence due to process changes. Detailed information is given on such accessories and modifications as packing, lubricant, vertical seals, water jacketed stuffing boxes, strainers and claw impellers, thus making the bulletin a presentation of complete service in the handling of corrosive solutions. (815). Duriron Company, Inc.

(5) Vibrating Conveyor

A bulletin is available on "Lo-Veyors" for conveying bulk materials. Most dry aggregate material can be conveyed by means of vibrations. This conveyor can handle a variety of products ranging in size from 5 microns up to large lumps. Materials of various moisture content can be conveyed depending on characteristics of material. The pan or tube through which the material actually moves may be a ferrous, non-ferrous or non-metallic flat pan either with or without cover, a round tube, a screen, a bar grate or any substantial carrier. It can be lined or coated for protection against chemical action, contamination, or water jacketed for cooling the product being conveyed. These details are engineered to fit the job. The drive mechanism of this shaker is described in detail in this catalog. (35). Ajax Flexible Coupling Company.

(6) Power Conversion

A new technical bulletin, offering a solution to the problem of low voltage power conversion through the medium of mechanical rectifiers, has just been released. As this bulletin was written to show the possibilities of mechanical conversion, rather than to cite specific applications, it is thoroughly detailed and should prove to be of interest to electrical men. The history of the mechanical rectifier is briefly traced from its origination by Siemens-Schuckert, of Germany, up to and including its development and modification for American applications. In addition to giving an elementary explanation of the theory of mechanical conversion, the new bulletin also contains a detailed explanation of the principles of the mechanical rectifier, including schematic diagrams of the various phases of operation. Though no specific

installations of the I-T-E- mechanical rectifier are illustrated, both a photograph and a dimensional outline of a proposed typical 5000-ampere unit are included. (4809). I-T-E Circuit Breaker Company.

(7) Pneumatic Control

A complete, air-actuated control system of advanced design, "Pneumatic Control," is presented in a 24-page catalog just issued. The post-war equipment described in this publication is said to be enabling users to obtain faster start up, smaller process swings, no process drifts, longer on-stream runs, faster recovery from upsets and shorter turn-around time. Diagrams and test curves show how this system provides not only: (1) proportional action and (2) automatic droop-correction (reset), but (3) stabilized rate action as well. Full-size photographs show the machine-like construction of the control mechanism. Other pictures show interesting and significant design features. Also illustrated is the simple, rapid method used by the operator to switch from manual to automatic control or vice versa, without causing any "bump" in process operation. Readers will find in this catalog a complete line of controllers . . . round chart or strip-chart models . . . "Speedomax" for regulating unusually fast-changing temperatures; "Micromax" for regulating all other temperatures or per cent SO_2, electrolytic conductivity or pH. (ND4B). Leeds and Northrup Company.

(8) Brush Standardization

A booklet is offered on standardization of carbon, graphite and metal-graphite brushes for motors and generators, which outlines a simple method of saving time and money for all users of motors and generators by illustrating how standardization can be accomplished. Conversion from a great number of custom-built, individually ordered brushes with random specifications to a smaller number having predetermined and unified specifications will make it possible to order brushes by a simplified RC number system. Brush standardization has saved individual companies hundreds of dollars by reducing the number of small orders and by purchasing in more economical quantities. It also effects a reduction in the number of stock items with savings in space and in handling time, less money tied up in brush stocks, and money saved on ordering, stock records and accounting. (B-2106). National Carbon Company, Inc.

(9) Dust Control

A bulletin entitled, "Industrial Dust Control," is available. The booklet contains information on the basic principles which apply to the control of dust in industrial plants. It gives reasons why a dust-free industrial plant is an economic asset. It tells how to attack a dust problem. It contains engineering information, including dimensions and capacities of dust filters. These filters operate on the principle of multiple vacuum cleaners, with a number of filter bags in proportion to the required capacity. The air after passing through a filter is clean and free from dust. The bulletin lists over a hundred different kinds of dusts which are collected by these filters. All processes which produce any kind of material in powdered form create a dust which in many instances would be an economic loss if not collected. Many other advantages of the control of industrial dusts are pointed out. (98). W. W. Sly Manufacturing Company.

(10) 65 and 80-Ton Diesels

General Electric has recently announced improvements in its standard model 65 and 80-ton switching locomotives. The changes in the diesel-electric units give increased power and improved continuous tractive effort ratings. The new locomotives are each equipped with two supercharged diesel engines with a maximum rating of 275 hp at 2100 rpm, or a total of 550 hp per locomotive. This is an increase of 38 per cent for the 65 tonner and 10 per cent for the larger model. The power actually delivered to the generators for traction is 420 hp. This compares with 330 hp in the old model 65-ton unit, and 440 hp on the old 80-ton locomotive. A bulletin is available giving complete information on these improvements. (GEA 4909). General Electric Company.

(11) Metallizing Equipment

A new catalog is available describing a complete line of metallizing equipment and supplies. "The Best of Everything for Metallizing" is the most complete catalog of metallizing equipment, accessories and supplies ever to be offered to industry. In it you will find metallizing guns for every purpose, air and gas controls, spray booths and dust collectors, blast machines and nozzles, and air compressors to give you clean, dry air. Each piece of equipment is clearly illustrated and described. There is also a description of each of the special metallizing wires. Three new accessories are introduced. (1) A wire control and straightener unit to increase spraying speeds and reduce wear on your gun. (2) A gas flow meter unit, the first of its kind, to assure maximum efficiency, higher spraying speeds and greater gas savings. (3) An air control unit that assures you of properly controlled air pressures. (401). Metallizing Engineering Company, Inc.

(12) Welding Procedures

An extensive line of bronze welding electrodes is fully illustrated and described in a bulletin entitled, "Welding with Bronze Electrodes." Considerable emphasis has been placed in the new bulletin on welding technique and procedures. A comprehensive weldability chart is included showing many diverse types of application with recommendations as to which Ampco bronze electrode to use in each case. Recommendations are unbiased since as this firm produces electrodes of aluminum bronze, phosphor bronze, beryllium copper and silicon bronze. Complete information is given regarding each grade or type of welding electrode. (W-17). Ampco Metal, Inc.

(13) Backstop

A new illustrated bulletin on an improved backstop is now available upon request. This 4-page bulletin provides complete, easy-to-read information on the construction and operating advantages of this backstop. The new backstop provides a positive method for preventing a reverse rotation on conveyor drives, elevator head shafts, windlasses, winches, and on all applications where reverse rotation should not occur. "Back-run" or reverse rotation in some machinery operations may cause serious damage to the machinery and the material being handled. In addition, expensive production delays may result. The gripping action of the backstop takes place at the precise moment that forward rotation ceases. It reduces the possibility of shock or strain to a minimum. (10,080). Falk Corporation.

(14) Gas Unit Heaters

"Pittsburgh" gas unit heaters, Series "C," featuring cast iron heat exchangers, are illustrated and described in a folder just published. Specifications for six sizes, with output ranging from 172,000 to 68,000 AGA Btu per hour, are included. Automatic Gas Equipment Company.

(15) Induction Motors

New bulletins are available on "Heavy-Duty" squirrel-cage induction motors. Cutaway and sectional drawings show details of welded frame construction, protective design, modern bearings and multi-layer insulation. Bulletin 1300-PRD-190 covers 2-pole and bulletin 1300-PRD-189 covers 4 or more pole motors. Electric Machinery Manufacturing Company.

(16) Continuous Heat Exchanger

A bulletin is available describing the "AMCO" recuperator. The bulletin tells why the continuous heat exchanger or recuperator is the only means by which preheated air can be supplied to a furnace continuously, and hence is the only means of giving uninterrupted acceleration to the production rate of a furnace. General design, operating characteristics and furnace applications are described, and cutaway views are used to show process. The principles of construction are discussed as well as the materials used in construction. Performance data with case histories of soaking pits and reheating furnaces are included. Every furnace operator should have a copy of this bulletin in his file. (292). Amsler Morton Corporation.

(17) Fan Size Table

A folder is available giving tables of fan sizes manufactured by various fan companies in the United States. Table I covers the multiblade and non-overloading fans, classes I and II, single inlet, single width. Table II covers the multiblade and non-overloading fans, classes I and II, double inlet, double width. (AIA file No. 30-d-1, form X-12). National Association of Fan Manufacturers.

(18) Plastic and Castable Refractories

Plastic fire brick and castable refractories are described in technical detail with typical applications and step-by-step directions for their preparation and installation

in a new 6-page bulletin just issued. Plastic fire brick applications described include boiler settings, oil burner installations, forge furnaces, annealing ovens, cupolas and other allied applications extending beyond the limits of standard plastic fire brick. Requiring no preparation for immediate use, H-W plastic fire brick is recommended for quick, economical emergency repairs. Among the numerous uses listed for H-W castables are lining irregular dimensions in small furnaces, and patching and casting special shapes which are required in a hurry. Castable refractories are also used for stoker installations, car tops, door linings and incinerator linings. The bulletin includes the temperature values of the three grades of castables, and helpful charts for determining individual castable and fire brick requirements. Harbison-Walker Refractories Company.

(19) Fuel Oil Additives

A new pamphlet on the latest development in fuel oil additives has been released. The new product, "Houghto-Solv," is described in the pamphlet as a speedy, effective industrial fuel oil additive that completely removes sludge from fuel oil systems. The folder also gives detailed information on how to use the product, how it works, and where best to use it. It also offers seven advantages this new solvent claims over its predecessors. The back cover of the new pamphlet illustrates an easy, practical way in which "Houghto-Solv" can be tested for merit. E. F. Houghton and Company.

(20) Surface Condensers

The condenser department of Elliott Company, has just published Bulletin C-9 (16 pages) on their Type F surface condensers. Built in sizes from 500 to 15,000 sq ft, the surface condenser is available in both divided and non-divided waterbox types. The bulletin includes data on condensate pumps, steam jet ejectors, duplex drainers, air leakage meters, as well as a pressure-temperature conversion table, chart for determining logarithmic mean temperature difference, and condenser formulas.

(21) Stress-Strain Recorders

Bulletin 262, 1 new 32-page catalog of Baldwin stress-strain recorders and strain followers, is announced by Baldwin Locomotive Works, testing equipment department. The bulletin describes, with pictures and diagrams, the basic principles of the various types of recorders; gives the distinquishing features of 24 different recorders for all common makes of testing machines; and describes more than 50 extensometers, compressometers and deflectometers that can be used with the recorders. The bulletin also shows typical stress-strain curves as produced by recorders, includes common testing accessories, and four types of strain gages.

(22) Permanent Magnetic Separators

A new 8-page, 2-color catalog describing the complete line of Eriez permanent non-electric magnetic separators, is now available. Complete specifications regarding weights, sizes and strength comparisons for various types of plate magnets are given as well as tables of operating capacities for permanent magnetic pulleys, drums, pneumatic line assemblies and pipeline traps. All types of magnetic equipment are fully illustrated through the use of photographs and engineering drawings.

Engineering service and laboratory facilities offered by the company, are also discussed. (12). Eriez Manufacturing Company.

(23) Coal Cleaning

A catalog is available entitled, "Heavy Media Float and Sink Processor for the Coal Producing Industry." The development of the heavy media process inaugurates a new era in efficient, scientific coal cleaning methods. It enhances the fuel value of the mine output which in many cases would be unsuited to meet market requirements. Mines having coal seams in which there is a considerable amount of high ash material can now be operated profitably and meet the requirements of critical markets. The heavy media process supplies the much needed facility to adequately and efficiently clean coal which has been produced by any mining method. The catalog explains the benefits to be derived from heavy media coal processing. The flexibility of separation through a wide specific gravity range has been definitely proved by actual operation. (148). Nelson L. Davis Company.

(24) Combination Burners

Due to fuel scarcity, you will be interested in a new catalog that is just off the press describing combination oil-gas burners. Many plants will need to change from gas to oil firing this winter. This burner permits the fuel switching quickly and without any change in equipment or loss of production. It is being used in all phases of industrial heating applications. (408). Hauck Manufacturing Company.

(25) Lubricated Plug Valve

A section of a valve reference book has been issued covering the Homestead-Reiser "Self-Seald" lubricated plug valve. The catalog section offers general data, descriptions, specifications and prices on the units, parts and accessories. From the full-threaded lubricant screw to its patented "self-seald" construction, each and every feature built into this valve was put there because the engineers and operating men of industry asked for it. Seven years of development and gruelling tests under scores of actual service conditions have brought you this new and different type of value construction, which, according to actual service records, affords the lowest cost per year fluid control of any valve within its service range. (RB39, Section 5). Homestead Valve Manufacturing Company, Inc.

(26) Molded Rubber Connectors

A bulletin is available on molded rubber cable connectors that are light weight, resilient, weather-proof and rugged and safe. This bulletin was designed so you can obtain a quick general picture of this company's diversified line. Detailed descriptions, prices and additional bulletins are listed. These connectors are built to take all the abuses the average mill man unthinkingly gives their electric plugs. This company also manufactures a socket that will stop harmful vibration and prolong lamp filament life. If vibration is burning out your light bulbs, then you should investigate this new vibrationless lamp socket. (MC107, B4-HO, S2371X). Mines Equipment Company.

(27) Absenteeism

According to statistics, there are 220 million person days lost to industry in the United States each year through respiratory diseases. This figure represents a waste of labor of about 740 thousand persons working for one year. Modern science has developed the use of ultra violet irradiation to combat this problem. Many industrial plants report a marked

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reduction in absenteeism by the use of ultra violet irradiation. A folder and other information concerning this method of killing respiratory disease germs is available to you. American Sterilizing Company.

(28) Bradford Breaker

A new bulletin is available on a versatile, efficient coal crusher, sizer and scavenger. The booklet gives a description of the Bradford breaker; it tells how the "Pennsylvania" Bradford works at the coal mine and coal cleaning plant, at the by-product coke plant where it prepares Run of mine coal for blending and eliminating oversize. It also tells how these breakers are used in the power plant. Detailed drawings and dimensions are given with complete data on capacities. Another bulletin is also available describing how the Bradford breaker removes debris, which is one of the headaches of coal preparation. (3007 and 3008). Pennsylvania Crusher Company.

(29) Lungs for Industry

A booklet is available entitled "Lungs for Industry." The catalog describes turboblowers, single stage and multi-stage units, gas boosters, exhausters, high temperature fans, exhaust fans and roof ventilators. Each of the varied types, arrangements, and constructions of blowers and exhausting equipment is subjected to rigid inspections and tests covering workmanship, performance and operating efficiency before shipment is made. Each wheel is in perfect dynamic balance prior to its assembly in the completed unit. The unit is then given a running test at the operating speed determined by the customer's specification or the fan application. Following this, each fan is run at speeds considerably in excess of that specified, in order to guard against performance failure resulting from any possible flaw in material or construction, and also to assure the smooth operation of the fan when installed. General Blower Company.

(30) Alloy Castings

A bulletin is available on nickel alloy steel castings in industry. Progress in industry is continually demanding increased power, higher speeds, heavier loads and longer service life in machinery and equipment parts that can be made most economically and efficiently in cast form. Ample strength and toughness are assured in such castings by the intelligent use of nickel and other alloying elements, and their inherent qualities can be modified and supplemented by suitable heat treatment. This catalog includes a description of steel rolling and forging and describes the various types of rolls used in rolling mills. International Nickel Company, Inc.

(31) Oil Seals

An excellently prepared catalog is available on "perfect" oil seals. These oil seals are available for shaft diameters as small as one-quarter inch, or with outside diameters as large as 48 in. These oil seals are so widely adaptable that they provide a solution for every fluid sealing problem. The booklet covers a description of the use of oil seals in industry, machine design suggestions, a description of the best installation methods for top performance, and includes cutaway drawings. Over 25 pages of this catalog are devoted to tabular detailed information on the various types of oil seals available for complete bearing protection. (947). Chicago Rawhide Manufacturing Company.

(32) Roll Grinder

A new bulletin is available describing a heavy duty roll grinder for precision production in heavy roughing or fine finishing. This roll grinder is equally capable of taking heavy cuts for rough grinding or the finest cuts required for the highest type of mirror finish. On either type of work it grinds rolls of all kinds faster than by any other method. Reports from users indicate that with the latest type of this machine, they are able to cut roll grinding time substantially, and at the same time obtain rolls with a perfect surface free from marks of any kind, and with straight, concave or convex contours ground to exact symmetry and accuracy. Productive capacities vary, of course, with the varying requirements in different mills. (115). Farrel-Birmingham Company, Inc.

(33) Soda Briquettes

A folder is available describing soda briquettes composed principally of soda ash (sodium carbonate), which is compressed into pellets approximately one and one quarter inch in length, one inch wide and five-eighths of an inch thick, and packed in 100 lb paper bags. They are used extensively by the steel industry and foundries with high powered results in the reduction of sulphur in iron. Blast furnace operators observe that they may burden their furnaces slightly leaner, produce more pig iron, yet be certain that they can deliver iron to the open hearth or bessemer departments within required analysis in sulphur content. Columbia Chemical Division, Pittsburgh Plate Glass Company.

(34) Coal Sampler

A folder is available telling what makes the "H and P" Thorsten automatic coal sampler tick. It tells how this automatic coal sampler is adaptable to any conveying system and can be used with belt or flight conveyors, elevators or chutes. Heyl and Patterson, Inc.

(35) Limit-Load Fans

A 68-page catalog is available on type "LL" limit load conoidal fans. This catalog will be a favorable edition to any user of fans in the steel industry. It offers tabular information giving specifications, dimensions, capacities and limit loads. We highly recommend this catalog. (3675). Buffalo Forge Company.

(36) Hydraulic Filter

A catalog is available giving complete engineering data on the "Marvel Synclinal" filter, designed to protect all hydraulic production equipment. This filter offers 2½ times the filtering service of equivalent sized units. It gives maximum filtration from minimum space and has standard 100 mesh insert. Other filters are available ranging from coarse 30 to fine 200 mesh inserts. These filters are adaptable to coolant systems as well as all hydraulic systems. The filter contains only six parts which are easily disassembled, cleaned and reassembled. (103). Marvel Engineering Company.

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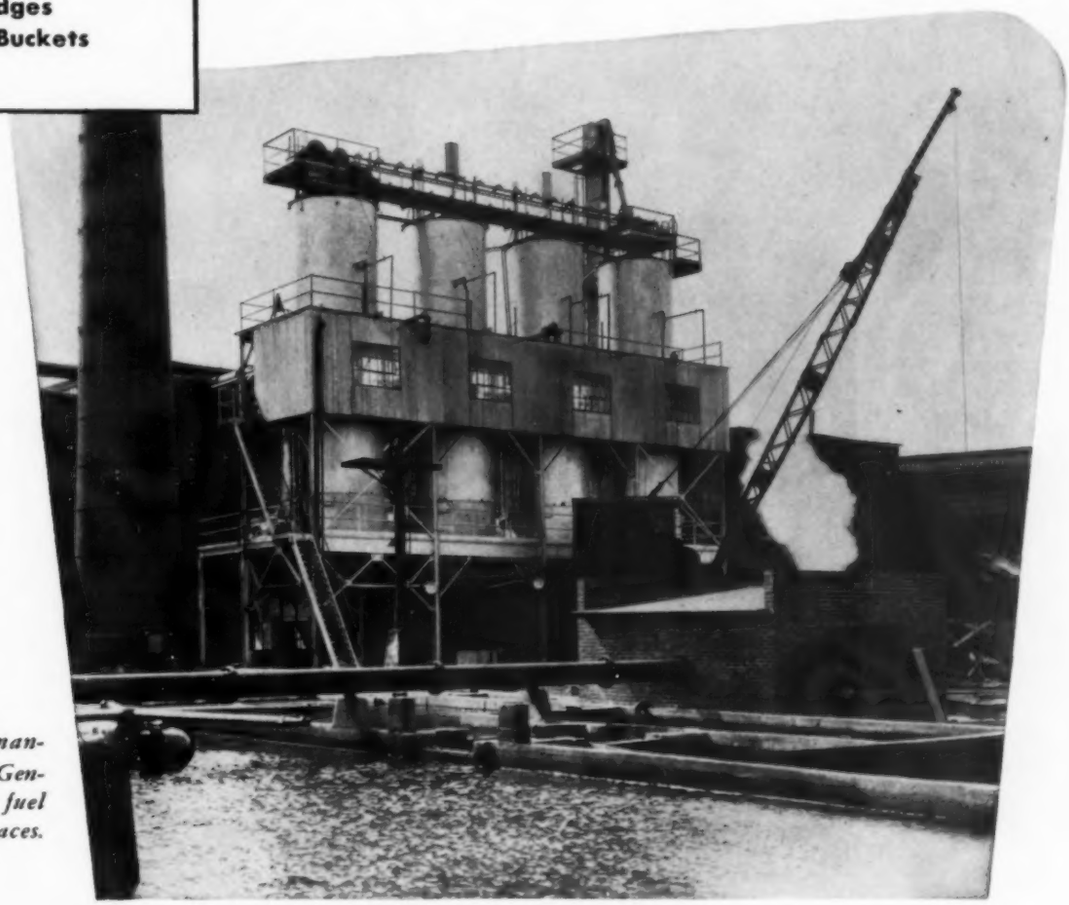

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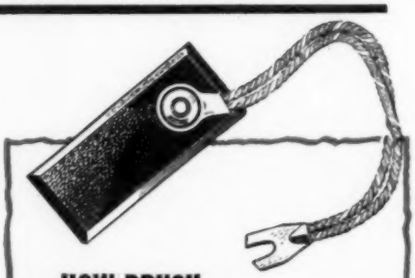

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Personnel News . . . .

Norman C. Rendleman, roll engineer, recently retired from Jones and Laughlin Steel Corporation. During his 44 years of service with J & L, Mr. Rendleman has developed a number of designs for mills, also rolls for special shapes and products, some of which have been patented. He served his apprenticeship at Inland Steel Company and started at J & L as a lathe operator in the South Side roll shop in 1904.

Burges A. LeMonte, formerly assistant roll engineer, has been appointed to succeed Norman C. Rendleman as roll engineer for Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania. Mr. LeMonte was first employed by J & L in 1925. His early experience was with Carnegie Steel Company in Gary, Indiana.

W. H. Maskrey was named manager of the Electricweld Tube Division of Jones and Laughlin Steel Corporation at Oil City, Pennsylvania, succeeding R. A. Campbell, resigned. **J. C. Lehner,** who has been works accountant at the Electricweld Tube division, will succeed Mr. Maskrey as general foreman. **W. J. D. Bell** of the J & L auditing division will succeed Mr. Lehner as works accountant.

F. X. Tartaron was named manager of ore research, a separate research division of Jones and Laughlin Steel Corporation. The Hazelwood laboratory group will carry on as the division of metallurgical research under the supervision of **Dr. H. T. Clark,** manager of metallurgical research. The third research group is the division of coal and coke research under the supervision of **C. L. Potter,** manager of coal and coke research. **Dr. H. K. Work,** who has previously supervised metallurgical and ore research, will join the office of the director of technology as a staff assistant with responsibility for research planning. **J. E. Morris,** formerly research engineer on a special development problem at Benson Mines, will become a member of the office of the director of technology as staff technologist to assist in the work of the general technical department. **H. W. Graham** is vice president and director of technology, supervising the three new research divisions.

M. A. Follansbee has been elected president of Follansbee Steel Corporation, Pittsburgh, Pennsylvania. Mr. Follansbee has been associated with the company for 32 years. As the son of a former president, the late William U. Follansbee, he started work in the plant. For 20 years he headed the company's Chicago sales office, returning to Pittsburgh as general sales manager in 1937. He was elected a director in 1940 and vice president in charge of sales in 1941. In July of this year, he was elected executive vice president.

C. E. Christman was elected chairman of the board, Follansbee Steel Corporation, Pittsburgh, Pennsylvania. Mr. Christman is president and general manager of Federal Enameling and Stamping Company, Pittsburgh, which company he founded in 1913. He has been its active head ever since. He was elected a director of Follansbee Steel early this year.

J. S. Ronay has joined Armco International Corporation, general engineers for the Argentina steel mill project. Mr. Ronay formerly was with Arthur G. McKee Company, Cleveland, Ohio.

Paul H. Startzman has been appointed general manager in charge of operations, Oliver Iron and Steel Corporation, Pittsburgh, Pennsylvania. Mr. Startzman has resigned his partnership in the engineering firm of Drake, Startzman, Sheahan, Barclay, Inc., to assume his new duties.

S. E. Graeff is now director of the Steel Company of Wales, Ltd., and a member of the managing directors executive committee. In his managerial capacity he acts as director, rolling mills. Mr. Graeff is a 1914 graduate of Miami University. He joined the American Rolling Mill Company as an apprentice at their Middletown plant. He was later at the Ashland plant during the development period of that mill. While he was at Armco, he made several trips to Europe where he assisted in the start-up of the high finish sheet mill of the Chatillon Commentry and Neuves Maisons Company in Commentry, France. In 1926 he returned to England and remained for approximately two years, assisting in the start-up of the high finish sheet mills of John Summers and Sons, Chester, England. He returned to England in 1937 when he joined Richard Thomas and Company, Ltd. (now Richard Thomas and Baldwins, Ltd.). This

NORMAN C. RENDLEMAN

BURGES A. LE MONTE

M. A. FOLLANSBEE

S. E. GRAEFF

company was just completing the installation of its hot and cold strip mill at Ebbw Vale in Monmouthshire. Up until recently, he divided his time between Richard Thomas and Baldwins, Ltd., and the Steel Company of Wales, Ltd., these two companies being rather closely associated.

The founder members of the Steel Company of Wales are Richard Thomas and Baldwins, Guest Keen Baldwins, Llanelly Associated Tinplate Companies, and John Lysaght, Ltd. The object of the new Steel Company of Wales, Ltd., is to modernize the tin plate industry of South Wales and to increase the production of flat rolled products in sheet and plate form. The entire scheme involves an expenditure of 70 million pounds sterling, and geographically extends from a specialty sheet works in Newport, Monmouthshire, in the east, to a tin plate works in Llanelly, Carmarthenshire, in the west. The main development is at the Abbey works, Port Talbot, Glamorganshire. At the Abbey works, the company is constructing blast furnaces, coke ovens, and a new open hearth plant. With this equipment, it is expected that the South Wales ingot production will be increased by some 25,000 tons per week. Also at the Abbey works it is intended to erect a modern continuous 80 in. hot strip mill, followed by plate finishing equipment and a heavy gage hot rolled sheet section served by both hot rolled coils and fly sheared material. On this same site they will also install a high speed, 80 in. wide, 3-stand tandem cold reduction mill. This mill will have a top speed of about 2500 fpm. Associated with this tandem mill will be the necessary finishing equipment.

At the Trostre site near Llanelly, they are installing a modern 5-stand tandem cold reduction mill, with a top speed of approximately 4500 fpm, to be used in the production of tin plate gages.

At Newport, where the Orb works of the Lysaght Company are situated (now owned by the Steel Company of Wales), they are planning to develop a specialty division, using reversing mills and operating primarily with silicon steels, with perhaps a certain tonnage of stainless flat-rolled product going through the same units.

Louis E. Rau was appointed branch manager at the new Buffalo branch of Crocker-Wheeler Electric Manufacturing Company, division of the Joshua Hendy Corporation. Mr. Rau's headquarters will be in the Ellicott Square Building, Buffalo, New York. A graduate of the Newark College of Engineering, Mr. Rau comes to Buffalo after several years on the staff of the New York district office.

Otto G. Schwenk has been appointed vice president in charge of production, Yale and Towne Manufacturing Company, New York, New York. Previous to his new appointment, Mr. Schwenk served as assistant to the president of Weatherhead Company, Cleveland, Ohio.

Tudor A. Wall has joined Kaiser Company, Inc., as administrative assistant to J. L. Ashby, vice president and general manager. His headquarters will be in the Kaiser Building, Oakland, California. A graduate of Dartmouth College with a degree in economics. Mr. Wall has had several years experience in business administrative capacities and was in the U. S. Navy for five years.

C. E. Tweedle, assistant to the president of the Askania Regulator Company, was elected vice president. Mr. Tweedle first became associated with Askania in

C. E. TWEEDLE

October, 1946. Prior to that time he served in the United States Navy as commander. A graduate of the Illinois Institute of Technology, Mr. Tweedle was engaged in consulting engineering work prior to the war.

Arden A. Freel was appointed superintendent of the yards and transportation department at the South Chicago plant of Carnegie-Illinois Steel Corporation. A graduate of Iowa State College, Mr. Freel's service with this United States Steel subsidiary plant began in 1936 as a practice apprentice in the engineering department. He became general yardmaster in 1941 and two years later was appointed supervisor of plant traffic. He has been assistant superintendent of the west mills department for the past two years.

R. R. Donaldson was appointed Hagan Corporation's new vice president in charge of engineering. Mr. Donaldson rose through the ranks, first to the job of chief

R. R. DONALDSON

engineer of the service department, then assistant chief engineer, Hagan Corporation; next, in 1946, as acting chief engineer, and last year became chief engineer.

Frank E. Scheliga has been appointed superinten-

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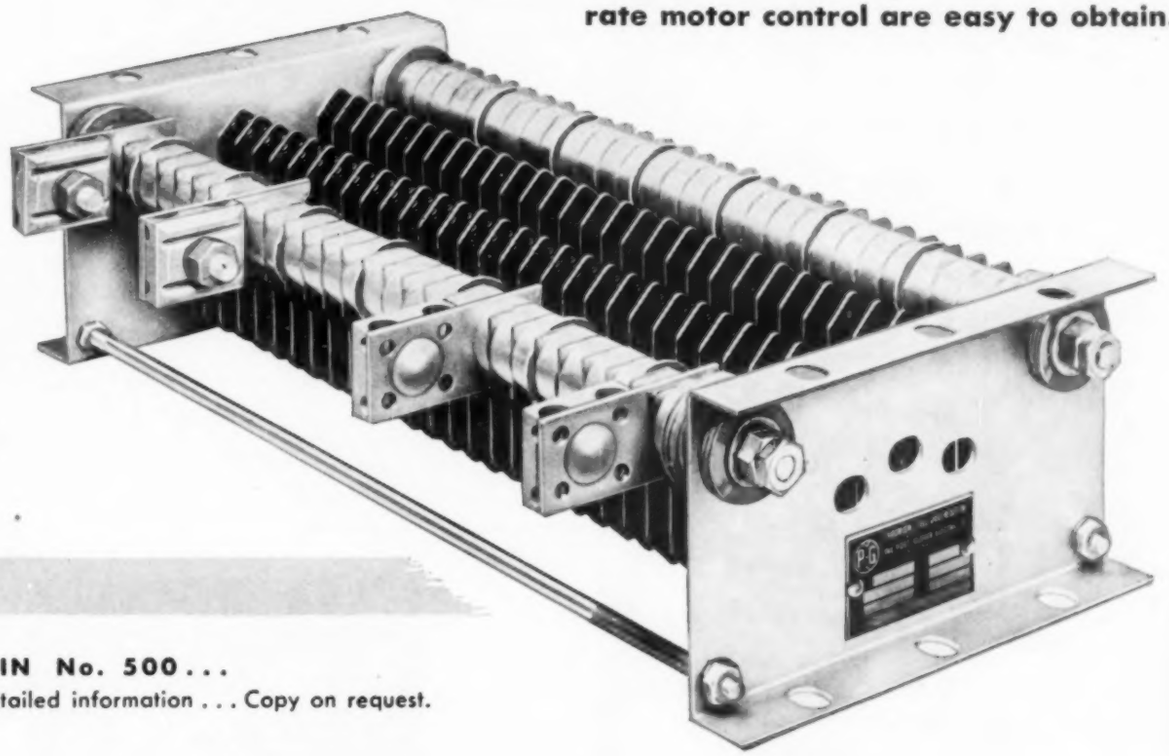

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dent, rolling mill, of the Torrance plant of Columbia Steel Company, Torrance, California. Mr. Scheliga joined this subsidiary of the United States Steel Corporation in 1938 as a laborer. In 1947 he was made assistant rolling mill superintendent, which position he has held until his present appointment.

Walter J. Bloom, who has formerly been associated with Weirton Steel Company, has been named vice president of General Sheet Steel Company, Detroit, Michigan. Prior to his affiliation with Weirton, Mr. Bloom had been employed by Otis Steel Company and Jones and Laughlin Steel Corporation in various metallurgical and sales capacities.

O. R. Schroeder has been appointed vice president of development and engineering of the Weldaloy Products Company, Detroit, Michigan. Mr. Schroeder was formerly director of metallurgical research for the Great Lakes Steel Corporation.

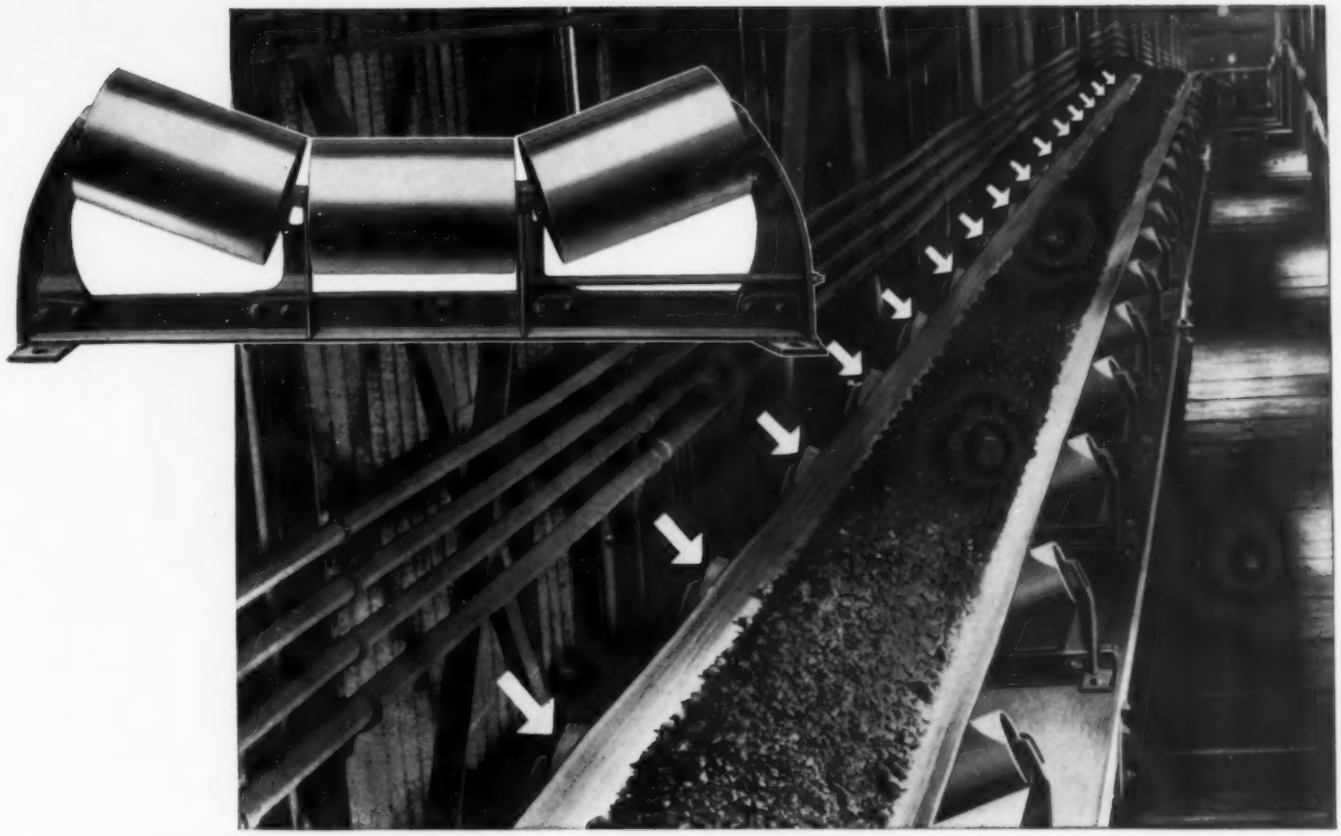
Frank T. Kalas, vice president in charge of sales and a director of Electric Storage Battery Company has retired after 49 years of service with the company. He is widely known in automotive circles as well as in the battery industry. During his long service with Exide, Mr. Kalas was manager of automotive battery sales and at one time manager of the company's Washington branch.

Roland Whitehurst, sales manager, has been elected vice president in charge of sales for Electric Storage Battery Company, Philadelphia, Pennsylvania. Mr. Whitehurst has been in the employ of the company for 40 years, starting his service with its New York branch. He was manager of the Washington branch for 20 years. In 1940, Mr. Whitehurst was appointed assistant sales manager of the company and in 1944 was promoted to sales manager.

H. W. Johnson was named vice president in charge of steel manufacturing for Inland Steel Company, Chicago, Illinois. Mr. Johnson came to Inland in 1929 as assistant superintendent of blast furnaces. In 1930 he

H. W. JOHNSON

was promoted to superintendent of blast furnaces. He was made assistant general superintendent of the company's Indiana Harbor works in 1942 and remained there until 1946 when he was appointed staff assistant to the president.



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In addition to idlers, Link-Belt builds a great variety of standardized design conveyor elements and accessories such as: belt and apron feeders for uniform loading; trippers for intermediate discharge or distribution; drives using gears, reducers and chains; terminal machinery; supporting structures and enclosures.

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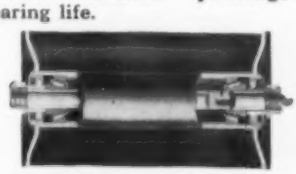
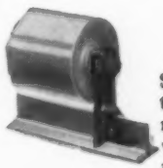


Rolls
made with smooth rounded-edge outer shell of uniform thickness, and a full-length steel central tube, both continuous-welded to dished steel heads to form sturdy, well-balanced integral units.



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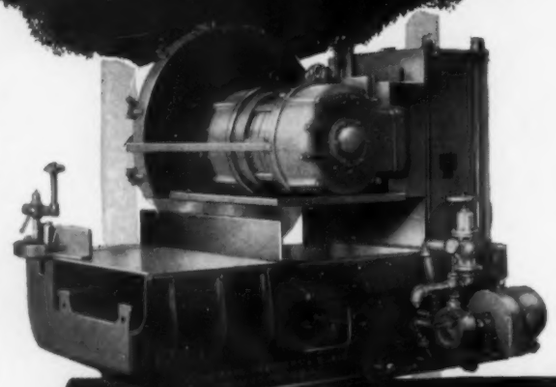
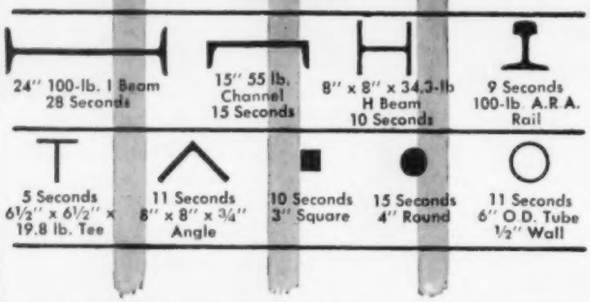
Interchangeable with steel rolls this type provides a Cushion at loading points to protect idlers and preserve the belt — A good investment where heavy lump materials are handled.

Modern Sawing



with KLING HIGH SPEED FRICTION SAWS



Friction sawing is one of few mechanical processes which employ the heat of friction in a useful manner. It concentrates heat on the material to be severed at a rate which is faster than it can absorb heat. The immediate temperature rise of the contact surface is so great that its strength is reduced considerably lower than that of the colder blade rim. This heated surface is readily removed by the blade and permits complete severing of the material rapidly with no loss of metal from the blade.

Because of its versatile ability to cut many varied structural shapes, as well as solid or hollow bars in any sequence, without change of blade or set-up, one machine can handle a volume of cutting that would otherwise require several separate shears or slow speed saws.

Consult Kling engineers regarding your metal cutting problems. State size of material to be cut. Bulletin No. 9200 giving full particulars and suggestions as to the type and size of saw will be mailed promptly. No obligation.

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Clarence B. Randall was appointed assistant to the president of Inland Steel Company, Chicago, Illinois.

CLARENCE B. RANDALL

He had been vice president in charge of raw materials since 1930.

P. D. Block, Jr., was appointed vice president in charge of raw materials, Inland Steel Company, Chicago, Illinois. Mr. Block had been assistant vice president.

P. D. BLOCK, JR.

He joined the blast furnace and coke plant departments in 1928, and in 1931, was transferred to the raw materials department. In 1935 he was named assistant vice president.

Joseph N. Banky, electrical engineer with Allis-Chalmers since 1943, has been named a sales representative in the company's Chicago district office. Mr. Banky received his master of science degree in electrical engineering from the Illinois Institute of Technology in 1947.

Samuel M. Gahagen, formerly of the Rustless Iron and Steel Corporation, Baltimore, Maryland, has been appointed chief metallurgist by the Jessop Steel Company, Washington, Pennsylvania. Mr. Gahagen previously served in metallurgical and other technical capacities with American Steel and Wire Company, Crucible Steel Company, the Vanadium Corporation, and finally the Rustless Iron and Steel Corporation before his

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Wherever you want to save time and money on refractories, it will pay you to consider Refractory Concrete. The adaptability of Refractory Concrete promotes economy in installation, maintenance and operation. It is a special type concrete for service at high temperatures—combining high cold-strength with strength under exposure to heat. In making Refractory Concrete, LUMNITE cement is used as a binder for a refractory aggregate, such as crushed firebrick or a high temperature insulating material. The mix is designed to give the service characteristics needed for the specific job. For free descriptive booklet, "Refractory Concrete," write to LUMNITE DIVISION, Universal Atlas Cement Co. (United States Steel Corporation Subsidiary), Chrysler Building, New York 17, N.Y.

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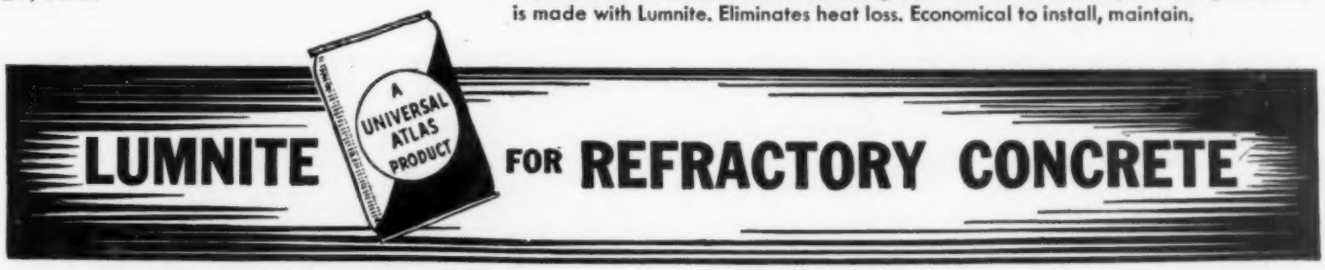

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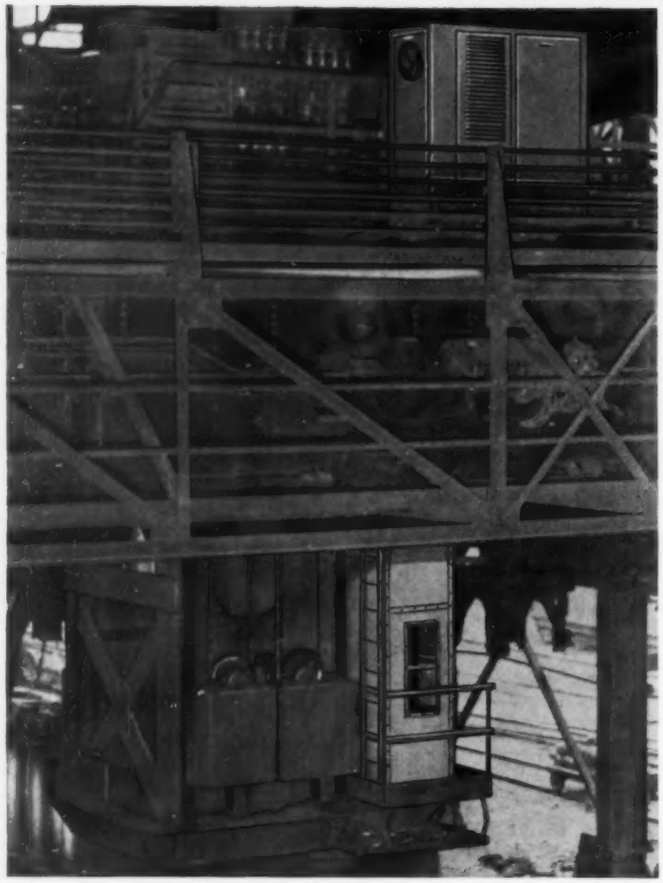

NEW Lintern Aire Rectifier

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These six advantages result: (1) Reduced engineering costs. (2) Big savings by elimination of expensive, efficiency-reducing air ducts. (3) Higher cooling efficiency in the cab. (4) Greater flexibility in location of all equipment. (5) Lengthened life of operating equipment because of protection from excessive radiant heat and greater accessibility for service. (6) Location of Aire-Rectifier on existing cranes without moving any equipment.

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THE LINTERN CORPORATION

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association with the Jessop Steel Company. He received his education at Pennsylvania State College, the Carnegie Institute of Technology, and the University of Buffalo.

Robert N. Merk is now superintendent of the galvanizing department for H. H. Robertson Company, Ambridge, Pennsylvania. Mr. Merk started with the

ROBERT N. MERK

open hearth department of Carnegie-Illinois Steel Corporation at Farrell, Pennsylvania, and became assistant to the open hearth superintendent at that plant. In 1944, he became assistant to chief engineer at the Homestead works of Carnegie-Illinois Steel Corporation.

Alden G. Roach now president of Consolidated Western Steel Corporation, will succeed **J. Lester Perry** as president of Columbia Steel Company, the steel-producing subsidiary of United States Steel Corporation on the Pacific coast. Mr. Perry, formerly president of Carnegie-Illinois Steel Corporation, was called back from retirement on May 1, 1947, to assume the presidency of Columbia following the sudden death of its president, William A. Ross. After November 15, 1948, Mr. Perry will remain with United States Steel, serving in an advisory capacity. For the last eight years Mr. Roach has been president of Consolidated Steel Corporation, which recently became a subsidiary of United States Steel under the new name of Consolidated Western Steel Corporation. Mr. Roach will continue as president of Consolidated Western Steel. The principal office of Columbia Steel Company is at the Russ Building in San Francisco. The headquarters of Consolidated Western Steel Corporation will continue to be at Los Angeles.

Charles B. Cleevely, foreman of crane repairs, has been appointed assistant superintendent of maintenance at the Campbell works of Youngstown Sheet and Tube Company. He succeeds August C. Jacob who retired recently. Mr. Cleevely is a native of Youngstown. At the age of 14 he joined Youngstown Sheet and Tube Company as a mail boy in 1904. Two years later he became a blue print boy, tracer and detailer in the engineering department and three years later became a draftsman in the electrical department. In 1915 Mr. Cleevely was appointed assistant foreman of crane re-

pairs and six years later became foreman, a post he held until his recent promotion.

Joseph Emrys Williams, formerly of Sterling, Illinois, has been appointed superintendent of Youngstown Sheet and Tube Company's rod and wire works at Struthers, Ohio, succeeding J. H. Shilling who retired recently. Mr. Williams, a native of South Wales, began working at the age of 17 as a laboratory assistant for Blaenavon Steel, Iron and Company, in South Wales and soon advanced to an open hearth helper. Shortly after he came to this country, Mr. Williams joined American Steel and Wire Company in Cleveland, Ohio. He later became superintendent of the wire mill for Northwestern Steel Wire at Sterling, Illinois, then plant superintendent for Reynolds Metals Company at Louisville, Kentucky.

J. Harvey Shilling has retired after 31 years with Youngstown Sheet and Tube Company, 14 years as superintendent of the company's rod and wire plant at Struthers, Ohio. Mr. Shilling, a native of San Francisco, joined Youngstown Sheet and Tube Company in 1917 as secretary to W. C. Reilly, general superintendent. He was made assistant superintendent of the rod and wire plant in 1920 and became superintendent 14 years later.

Joseph F. Collins, safety supervisor for the eastern district of Youngstown Sheet and Tube Company, is the new chairman of the metals section of the National Safety Council. Mr. Collins was elected at the National Safety Congress in Chicago to succeed Frank Kelsey of Jones and Laughlin Steel Corporation. This is the largest section in the National Safety Council and includes 825 companies in all parts of the country.

Richard R. Ruthrauff was made assistant superintendent (utilities) for Carnegie-Illinois Steel Corporation, Duquesne, Pennsylvania. Mr. Ruthrauff was graduated

RICHARD R. RUTHRAUFF

from Carnegie Institute of Technology in 1940 with a bachelor of science degree in electrical engineering. In June, 1940 he started with Carnegie-Illinois at Duquesne as a practice apprentice. In June 1941 he became a special engineer, and in October, 1946 he was appointed assistant electrical foreman. In May, 1947 he became assistant general foreman and in January, 1948 was appointed general foreman (blast furnace maintenance).

Charles H. Good, Jr., was appointed assistant superintendent of maintenance (assigned and operating) at Carnegie-Illinois Steel Corporation, Duquesne, Penn-

CHARLES H. GOOD, JR.

sylvania. Mr. Good is a 1942 graduate of Carnegie Institute of Technology, holding a bachelor of science degree in mechanical engineering. He started in December, 1939 as an engineer of tests at the Duquesne works of Carnegie-Illinois. In March, 1944 he was appointed assistant superintendent (fuel and steam power). In January, 1948 he was named assistant superintendent (utilities).

W. V. O'Brien was named general sales manager of General Electric's apparatus department. Mr. O'Brien has been assistant general sales manager since December, 1947. He will continue to direct the co-ordinated sales activity of the apparatus department's sixteen product divisions through apparatus sales offices located throughout the country. Mr. O'Brien has been associated with General Electric since 1922, when he entered the company's "test course." He served in several sales engineering capacities in the company's southeastern district from 1924 until 1937, when he returned to Schenectady as a proposition engineer in the central station division. He was named assistant to the manager of the lighting and cable division in December, 1938; manager of the wire and cable division in March, 1940; and assistant manager of the central station division in January, 1945. Appointed manager of the central station divisions in April, 1945, Mr. O'Brien served in that capacity until his appointment as assistant manager of sales in December, 1947. Mr. O'Brien is a native of West Virginia, and was graduated from the Virginia Military Institute in 1922 with a bachelor of science degree in electrical engineering.

Carl J. Murray was named general superintendent of Jessop Steel Company, Washington, Pennsylvania. He was previously assistant manager of Colorado Fuel and Iron Corporation and earlier was plant engineer of Crucible Steel Company. **Edward J. Sherrill** was appointed superintendent of production scheduling and shipping. He previously served in the same capacity for

Colorado Fuel and Iron Corporation, and earlier was manager of the inbound traffic division for Michigan Central Railroad. **Ellsworth E. Seitz** is now director of personnel relations. He was previously a plant engineer and engaged in personnel work at the Chevrolet plant in Buffalo. **Norris B. McFarlane** has been made superintendent of the electric furnace department. He previously held the same position at Universal-Cyclops Steel Corporation and earlier worked in the open hearth department of National Tube Company. **Edwin C. Thomas, Jr.** becomes superintendent of the bar mills. He was previously assistant superintendent of the rolling mills at Atlas Steels, Ltd., and earlier was a roll designer at Universal-Cyclops Steel Corporation. **James O. McDowell** was made superintendent of the sheet mills. He previously worked in the same capacity at International Nickel Company and prior to that worked at the Wheeling Steel Corporation.

Yale T. Chaney has been appointed manager of distribution systems sales of the Trumbull Electric Manufacturing Company, Plainville, Connecticut. Mr. Chaney joined Trumbull in 1937 in the engineering department of their plant in Ludlow, Kentucky. In 1945 he became resident engineer, working with General Electric in Schenectady, New York. He held this position until his appointment as manager of distribution systems sales at Plainville, Connecticut. Mr. Chaney is a native of Dodsonville, Ohio. He graduated from the University of Cincinnati with a bachelor of science degree in electrical engineering.

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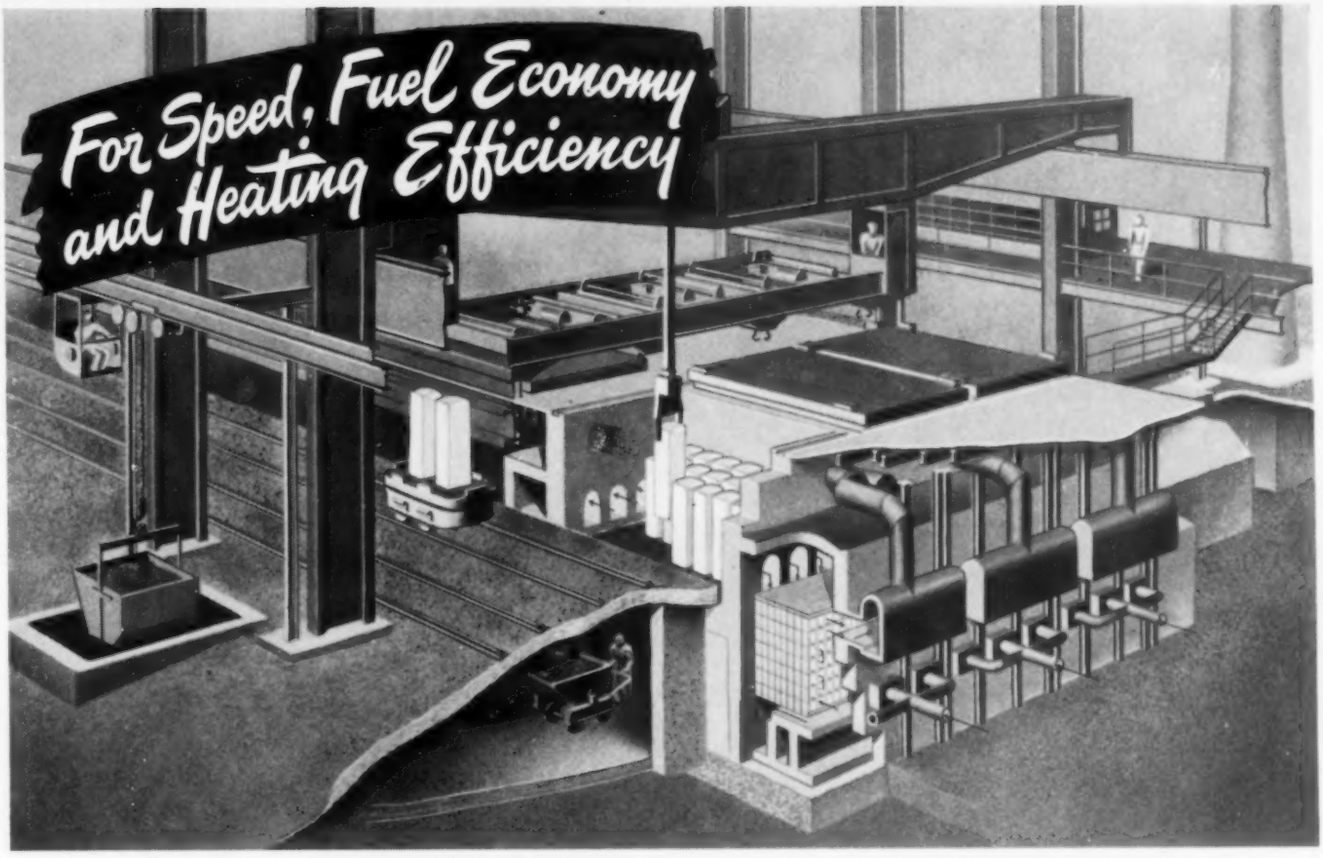

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Two-way top fired ▲ Completely automatic ▲ Recuperative type ▲ All fuels

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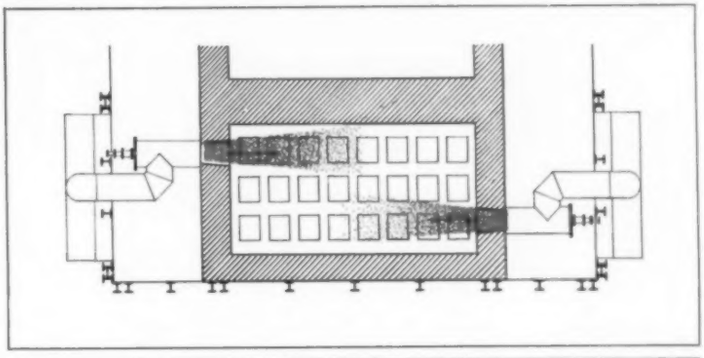

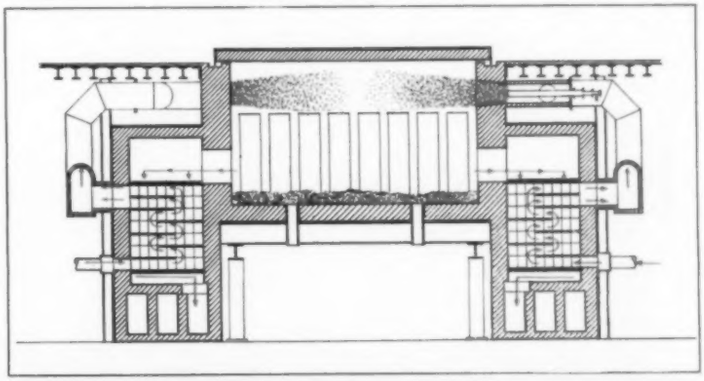

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Wide Double Contact Surfaces — Spring Tension Locking of Links

KNIFE-BLADE
250 VOLTS
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We manufacture all of our own parts and are making prompt deliveries.

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250 VOLTS
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William A. Edwards has been appointed manager of switch, breaker, control sales of the Trumbull Electric Manufacturing Company, Plainville, Connecticut. Mr. Edwards joined Trumbull in 1924 as a member of the advertising department in Plainville, Connecticut. In 1942 he became the manager of the Kansas City office and in 1943 he was the district sales manager of the southwest district. He has now returned to Plainville as manager of switch, breaker, control sales. A native of Southington, Connecticut, Mr. Edwards graduated from Hillyer College in Hartford, Connecticut.

Joe S. Thomas was appointed director of purchases of Armco Steel Corporation, Middletown, Ohio. Mr. Thomas fills the vacancy caused by the death of Newman Ebersole who passed away in September. He joined the Armco organization in 1927, directly after graduation from Cornell University where he received a degree in mechanical engineering. He was given special sales training, and in 1928, was transferred into the home office of the Armco sales division. He occupied a number of positions in the home office and in 1935, was sent to New Orleans as a sales representative. In February, 1941, he was appointed assisfant to director of purchases and on July 1, 1947, assistant director of purchases.

Charles Beck was named manager of raw materials supply, Armco Steel Corporation, Middletown, Ohio. Mr. Beck first became associated with the company as a vacation worker while attending Purdue University. Upon graduation with a degree in mechanical engineering, followed a post-graduate course in metallurgy at Ohio State University, he joined the Armco organization on a full time basis in 1926, working at the company's blast furnaces in Columbus. He then transferred to Armco's Ashland plant and in 1927, to the Middletown plant. In 1934, he was appointed superintendent of the processing department at Middletown, and in 1944, assistant general superintendent of the Middletown division. He held this position until being made manager of raw materials supply.

Obituaries

L. H. Burnett, a former vice president of the Carnegie-Illinois Steel Corporation, died October 26 in Monmouth Hospital, Long Branch, New Jersey. Mr. Burnett, who retired in 1941, was the mayor of Sea Girt, New Jersey, at the time of his death. He was 74. Born in Springfield, Ohio, Mr. Burnett came to Pittsburgh in 1901 as a clerk to the general solicitor of Carnegie-Illinois. Later he became vice president of the Carnegie Land Company and assistant to the president of Carnegie Steel Company. In 1927, he assumed vice presidency of Carnegie-Illinois. He retired in April, 1941, after 40 years service, and moved to Sea Girt.

Arthur H. Wyman, Cleveland district manager for Allis-Chalmers Manufacturing Company, died Tuesday, October 5, 1948. He was born in DesMoines, Iowa in 1883. He was a graduate of Iowa State University with a degree in mechanical engineering. Mr. Wyman was employed by Allis-Chalmers Manufacturing Company in Milwaukee in 1907 and after holding several positions in Milwaukee and in various western sales offices was sent to Cleveland twenty-three years ago as the district manager, the position he held at his death.

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News Supplement

(*Continued from page 144*)

▲ As a result of continued research and experiments with war time equipment, it is now possible to produce seamless tubes and pipes in sizes more than double those available before the war.

A 4000-ton extrusion press, installed at International Nickel Company's Huntington works during the war and used largely for the production of rotating shell bands, is now producing pipe in nickel, monel and other high nickel alloys in diameters up to 9¼ in. and in lengths up to 12 ft.

These shapes can be further cold drawn into seamless pipe 8 in. in diameter, wall thicknesses up to ¾ of an in., and in varying lengths.

Prior to the war, the largest size available in pipe and tubing of nickel and the high nickel alloys was 5 in. in diameter. Since the end of the war the firm has been endeavoring to increase the size ranges up to the present limits.

While large piping and tubing in the Inco nickel alloys have been available in centrifugally cast or welded form, this is the first time they have been made in these sizes by forging, extruding, and cold drawing into seamless form.

▲ A further expansion in its line of "Kennamatic" tools has been announced by Kennametal, Incorporated, four heavy-duty tool styles are now available, two having square inserts and two having cylindrical inserts of solid Kennametal cemented carbide.

These tools utilize the successful "Kennamatic" principle of mechanically holding an indexable insert in vertical position, in order to make best use of the high compressive strength of the insert.

The indexable insert is held in vertical position mechanically.

Heavy duty styles 3RK-6RK have cylindrical inserts that are 1½ in. in diameter x 2¼ in. long, held in 2 in. square or 3 in. square steel shanks. These tools are intended primarily for machining cast-iron.

Heavy duty Styles 11SK-12SK are available in two shank sizes—2 in. square having 1 in. x 1½ in. square Kennametal inserts; 3 in. square having 1¼ in. x 2 in. square Kennametal inserts.

BOOK REVIEW

▲ Sponsored by the very active Committee D-20 on Plastics, this greatly amplified fourth edition of the ASTM Standards on Plastics, dated September, 1948, gives in their latest approved form, the more than 100 specifications and tests covering a wide range of plastics and related materials.

Specifications covering molding compounds include the following: phenolic; polystyrene; cellulose acetate; vinylidene chloride; methacrylate; nylon injection; melumine—and urea—formaldehydes, etc. Also given are requirements for cast methacrylate sheets, rods, etc.; laminated thermosetting materials; rubber and synthetic rubber compounds; machines and servicing units for tests at subnormal and supernormal temperatures; and nonrigid polyvinyl tubing; along with many others. Three specifications cover nonrigid plastics — vinyl chloride-acetate, vinyl chloride, and vinyl butyral; under radio applications are found phenolic laminated sheet, and round phenolic laminated tubing.

Also included in this book is a descriptive nomenclature for plastics and standardized terms relating to plastics, conditioning and weathering, methods of testing, rheological properties of matter, and specific gravity.

This 610-page book, in heavy paper cover, can be obtained from ASTM Headquarters, 1916 Race Street, Philadelphia 3, Pennsylvania, at $4.50 per copy, reduced prices are in effect on quantity orders.

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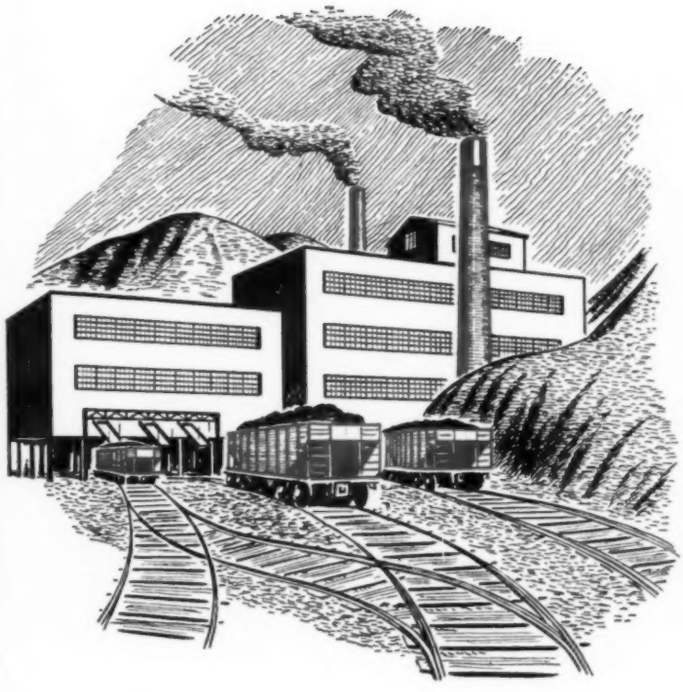

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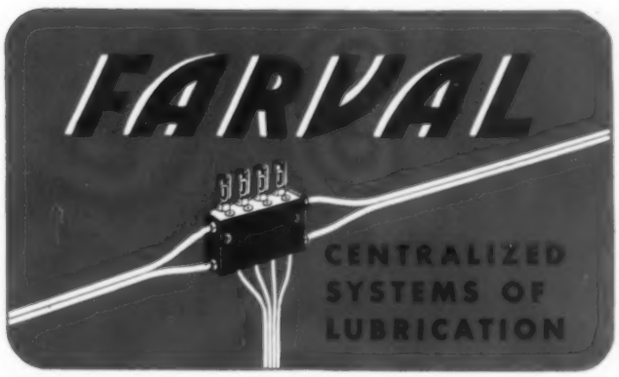

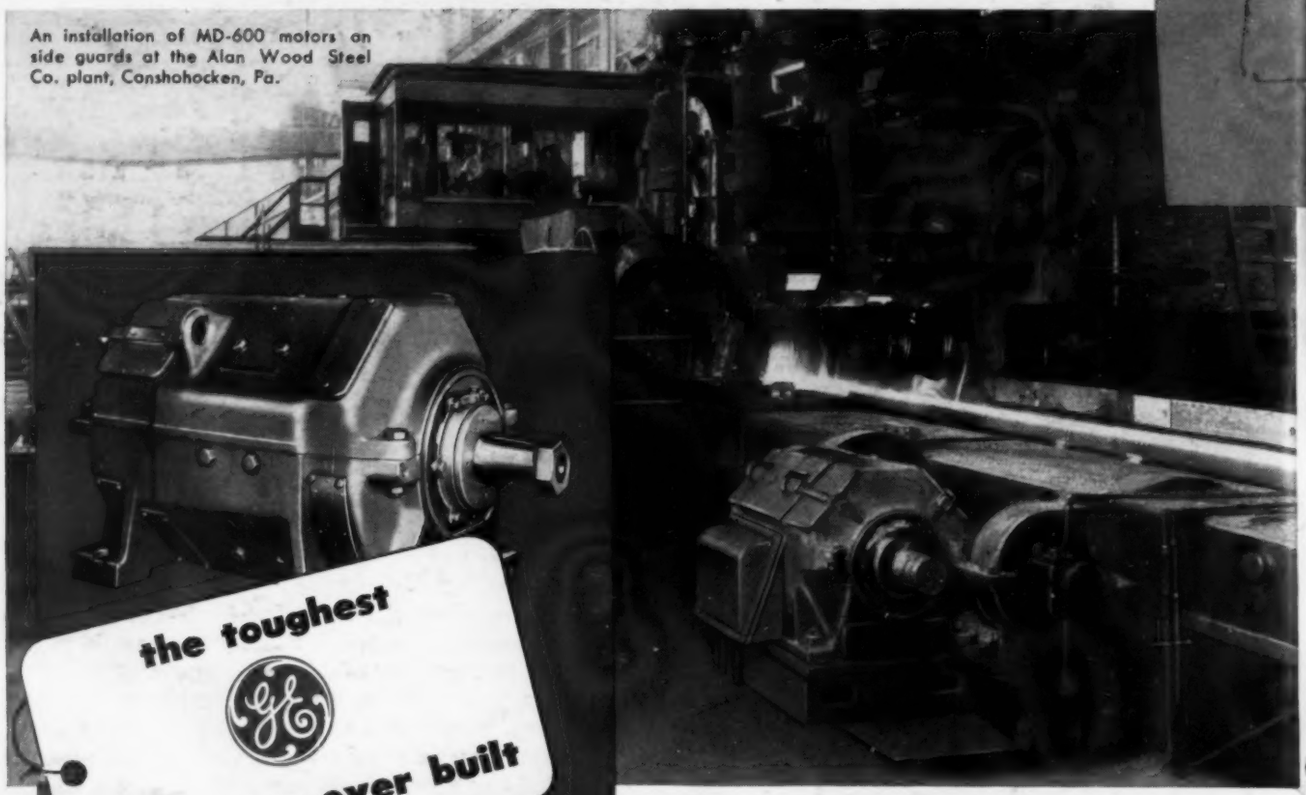

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